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H. A. Du Bois Jr

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RUDIMENTS

OF

PATHOLOGICAL HISTOLOGY.

BY

CARL WEDL, M.D., Etc.

WITH 172 ILLUSTRATIONS ON WOOD.

TRANSLATED AND EDITED

BY

GEORGE BUSK, F.R.S.

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AUTHOR'S PREFACE.

The development of every science is determined within certain laws, which cannot be transgressed without risk of the inquirer's losing himself in a bottomless abyss. At all times there have been men who have pursued the comprehensive, rational, inductive method in the study of pathology; and it is a pity that at certain periods these have been replaced by mere hypothesis-mongers. The anatomico-chemico-physical method of research at present followed in the cultivation of pathology has opened out a rich mine of results. The adoption of the pathologico-histological course pursued in this work has only of late been rendered possible with the aid of the microscope and of the advanced state of knowledge in normal histology,—an acquaintance with which is here presupposed. But our progress in this direction has not, as yet, been so far successful as to allow of the erection of a complete system; an incompleteness which is indicated in the title selected for the book—viz., "Rudiments of Pathological Histology."

The object of the work embraces a morphology of anomalous tissues, with due regard to their development, the observations being based chiefly upon original researches. The labours of others, whose names are cited, have been

copiously employed; and the reason why the literature of the subject has not received more particular notice lies in our allotted space, which, even without that, has been overstepped. As the work is intended for study, the author has conceived that the object would be best attained if the various subjects were described as much as possible in an objective way, by means of instances accompanied with the requisite illustrations; thinking, also, that the book would thus be rendered more attractive to the practitioner. The technical execution, moreover, has, throughout, received due attention.

The plan followed in the work has been the giving, in the first place, as a methodical foundation, general morphological views and theories of development with respect to *exudations*, *atrophy*, *hypertrophy*, the *formation* of *inorganic* and of *organic* substances, and particularly of new-formed elementary organs and their various combinations.

In the Special Part, the subjects treated of are arranged in Families: I. Inorganic formations; II. Atrophies; III. Hypertrophies; IV. Exudations; V. New-formations; VI. Parasites. The processes are described as manifested in the various organs; but in this no strict anatomical or physiological order has been observed, those organs being taken first which had been more especially investigated, or which, in their anomalous structural conditions, were found more particularly adapted to afford useful results. In the extensive family of "new-formations" the respective pathological structures are arranged in divisions, ideal forms, or categories, not very strictly defined,—the opinion at the same time being held that, although such an arrangement and nomenclature might be requisite for the proper appreciation

of the subjects, they should by no means be taken to represent a logical, systematic classification, inasmuch as one category passes into another.

In all the original measurements the French scale, as most convenient to every one, has been adopted.

With respect to the illustrations, which, in a subject of this kind, are so indispensably necessary, the author would remark that no time nor trouble were spared to render the drawings clear and correct. With the exception of six figures belonging to the parasites, the 203 illustrations are all original, some having been made by the author's brother, but most by himself. The zylography was executed by A. Rosenzweig, who devoted sixteen months to the troublesome task.

It is obvious that the publication of an illustrated work requires considerable time; and the delay in the appearance of the present book is thus partly accounted for, and partly, also, because it was preferred that it should appear complete, and not in Parts. These considerations are adverted to by the author in apology for his not having paid more regard to several recent works in the same field.

CARL WEDL.

VIENNA, *July*, 1853.

TRANSLATOR'S PREFACE.

The object and scope of the present work are sufficiently shown in the Author's preface and in the table of contents; it is needless, therefore, to say more than that it does not profess to be a complete system of 'Pathological Histology'; the time for the completion of such a work not having yet arrived. General Histology, of which, in fact, that of morbid productions is merely a part, though undoubtedly much advanced of late years, is still, as the author says, in many respects far too defective to allow of the production of anything that can be considered a complete and satisfactory system. Observation shows more clearly, day by day, that the doctrine respecting the formation of pathological products, is subordinate to that which embraces the development of all organized tissues—that the mode of development, so far as it proceeds, is the same in both; the difference between the two consisting merely in the varied impulse under which it starts in either case. Whatever, therefore, of truth or error may exist in the received opinions respecting the formation of tissues in general—will apply as well to that of pathological, as of normal products. Among the more important of these views are those which relate to the doctrine or theory of cell-formation. The almost blind obedience at present paid to

the doctrines of Schwann and Schleiden, has apparently acted, for some time, as a damper upon original thought on the subject. Attention, however, having of late been directed, more particularly by Mr. Huxley,[1] to the foundation upon which this doctrine is based, and to the many and weighty objections to which it is obnoxious, will, it is to be hoped, awaken a more scrutinizing and independent spirit of inquiry—when, and not till when, we may hope to see General, and with it Pathological, Histology, placed on a firm basis.

At present, therefore, the chief value of any work on the subject will consist in the amount of original information in the shape of facts which it may contain; and, in this respect, credit is eminently due to Dr. Wedl's labours. The extent of original information and of original illustration in his work will always entitle it to a high place. His views also, especially with respect to *cancer* and new-formations in general, are comprehensive and suggestive; and his treatment of the subject, though not altogether the most simple, is, upon the whole, as good and perhaps more philosophical than most others hitherto propounded.

In this edition, it is necessary to remark, that a few of the observations, or rather directions, concerning the means to be employed in histological and microscopical research, and in the preservation and preparation of specimens have been curtailed, as needless, in the presence of special works, at any one's command, on such manipulatory matters.

Several of the detailed cases, also, have been omitted, when they appeared superfluous for the strengthening of a

[1] 'Brit. and For. Med.-Chir. Review,' vol. xii, p. 285. (1853.)

statement; as well as the entire chapter on the subject of Parasites—one apparently quite out of place in a work devoted, not to General Pathology, but, simply, to Pathological Histology.

The measurements, in the original, are given in parts of the French millimetre, but in the translation (with a few exceptions from inadvertence) they have been reduced to terms of the Paris line (‴) (0·088 inch) and inch (″). To render the book more convenient for reference, an Index has been appended, in addition to a copious table of 'contents.'

The descriptions of the figures, usually placed at the bottom of the pages, are here given together at the end of the book—an arrangement which it is hoped will be found convenient for reference.

G. B.

May, 1855.

PART I.

CHAPTER I.

GENERAL OBSERVATIONS.

THE abnormal conditions of tissues are the *subject* of Pathological Histology, and the elucidation of these conditions constitutes its *object*. Though chiefly a descriptive science, that is one concerned with the morphological changes in diseased structures, and which, as such, might be termed a morphology of the latter, it is nevertheless simply impossible to limit its range to mere description, to the exclusion of all reflections on the matters thus described, since even the sifting of the materials afforded in this way can only be undertaken, with any success, according to certain principles dictated by an ordinating intelligence.

The *task* of the science is thus at once obvious; viz., to afford a knowledge of the morphological conditions presented in morbid tissues. The limits within which its province lies are accurately defined, as are also the relations in which it stands towards other allied branches of pathology.

The sources whence the latter immediately derives its materials are:

1. Pathological Anatomy, of which pathological histology is a constituent part, precisely as microscopical anatomy or histology is an integral part of Physiological Anatomy.

2. Pathological Chemistry—a branch of general chemistry, as applied to the study of pathological products.

3. Experimental Pathology, whose task it is, by the systematically arranged concurrence of known conditions, to elucidate pathological processes—doubtless sources from which the best results, and incontestable proofs of the nature of the morbid processes will flow.

This experimental inquiry alone will lend a vivifying breath to the facts derived from pathological anatomy and chemistry; and in a scientific point of view it becomes the living factor of the dead morbid product.

Pathology is a theoretical science of disease, both general and special, based upon physical, chemical, and anatomical facts, whose foundations are of course, at present, laid only upon imperfect fragments, but the erection of which is impossible without the strenuous culture of all collateral branches of knowledge. How far we still are from a scientific pathology of this kind will be obvious to every one who is sensible of the deficiencies in our physiological knowledge.

The obstacles opposed to the investigation of this obscure subject are by no means trifling, and the inquirer must never relax in his struggle to overcome them, striving always to gain a sure footing as he advances. This sure footing consists in acute observation, guided by the judgment.

The proper cultivation of these collateral branches of pathology has not been pursued till recent times. Since it has been perceived that pathology can be rationally advanced only upon a physiological basis, we have no longer been contented with the assemblage of symptoms, as constituting a *species* of disease, any more than a zoologist of the present day is satisfied with the mere outward form of the animal, but is also obliged to take into consideration the internal structure associated therewith.

The pathologist must now be acquainted with the morbid textural changes of organs according to the present condition of science, those changes constituting the only positive basis of a rational pathology.

Returning to our subject, we may regard it either from a general point of view, or we may treat more specifically of the anomalous conditions of tissues, their origin, progress, and

retrogression. From the former of these modes of treatment arises the General Part of Pathological Histology, in which, together with the methodical doctrine of congestion, inflammation and exudation, will be described in general terms, the pathological changes of normal cells, the development of newly-formed cells, the formation of fibres, of the areolar tissue, and of the papillary new formations, of cysts, vessels, &c. The Special Part includes the morphological changes of the particular organs, which may be considered and treated from a double point of view. The morbid processes in the various organs may either be arranged in groups, by which means their similarity or diversity is more readily perceived; or the organs may be taken according to their anatomical and physiological order, with the morbid products belonging to them. Each of these methods has its advantages and disadvantages; but we think it necessary to adhere to the former, which, as has been observed, ensures a more comprehensive survey of the subject, and as by so doing, the analogy and heterogeny of the processes are rendered more obvious, whilst the repetitions so irksome to the reader are avoided, at the same time that the numerous deficiencies in our knowledge will be less sensibly felt.

It is by no means an easy matter to define what constitutes an anomalous condition in a tissue, seeing that the normal texture of an organ is subject to many alterations, within the limits of health. The excessive size or minuteness of an elementary organ (cell), its altered relative position, its changed contents, the various conditions of the *nucleus*, &c., are points demanding assiduous and strenuous investigation. In order to render the matter clearer, we will here adduce some instances. The presence of fat in the contents of the hepatic cells is connected to a certain extent with the conditions of nutrition; and we should be very wrong, where the fat is present in small quantity, and without any other complication, at once in assuming the existence of a fatty degeneration of the cells. The same holds good with the fatty contents of the epithelial cells of the kidney, in which also the presence of fat depends to a certain extent upon the nutritive condition, and by itself alone, in a minor degree, should not be regarded as pathological, or in fact as at all sufficient to constitute a "Bright's

kidney." The retrograde or atrophic modifications also of the tissues, occurring in old age, have not the same significance, in a pathological point of view, as they would have in younger individuals. A certain amount of atheromatous deposit in the vessels of a person eighty years old would necessarily be referred to the involution proper to the physiological condition at that period of life; whilst the same degree of the affection in the vessels of a youth of twenty would indicate a partial premature retrogression of the organism, and could only under such circumstances be of pathological interest. Hence it is evident that in the exposition of the abnormal condition of a tissue, due regard must be paid to all the circumstances, and the more so in proportion as the anomalous state is less determinate.

To solve the problems of pathological histology it is not sufficient to give a precise description of the anatomical condition, that is to say, of the elementary constituents, their connections and relations in various parts of the diseased organ, but an attempt must also be made *to develop the origin, progress, and retrogression of the abnormal tissue, upon anatomical data.* It cannot be denied that in the undertaking of this exposition of the elementary organs, a dangerous rock will have to be weathered; but on the other hand, it must be allowed that the history of the development, progress and retrogression of pathological tissues, is a most important and necessary aid in pathology, and in fact, the only true basis upon which a rational pathology can be founded.

With respect to the *means* by which pathological observations are to be carried on, and histological researches made, it is, in the first place, requisite that the observer should be furnished with optical instruments in which he can have full confidence. The mode of investigation must be directed by the nature of the question to be determined, and the best proof that the mode of inquiry adopted is that most fitted to the case, will consist in the clearness with which the anomalous structural conditions are displayed. The clearer the image obtained from the preparation the more satisfactory will be the result of the observation; care and pains, therefore, must not be spared in the making of a preparation, time and trouble thus bestowed being amply compensated by the additional facility in the carrying out of the observation. Preparations carelessly made

are always more or less deceptive; and the time, however little, thus employed is, in great measure or wholly, lost. The *methods* followed in pathological histological researches may be described, as it were, as *synthetic*, and as *analytic*. The latter commences with the elementary constituents, and proceeds to inquire into their disposition, and relations to other elementary parts, their various chemical properties, their diversities in different parts, &c. In the *synthetic* method, the secondary arrangements of the elementary parts grouped together, are investigated. For the *analysis*, the most powerful object-glasses of the compound microscope are employed; for the *synthesis*, the lower powers and the simple lens. The course to be pursued in any particular case depends upon the plan of the investigation.

The *simple lens* or microscope, is an indispensably requisite instrument, and every observer should take care to be provided with good lenses of this sort, with which alone many observations in their totality can be undertaken—as for instance, the distribution of the larger blood-vessels, their course and relations to various parts of a tumour: or the areolated tissue of a cystic thyroid gland, &c.

It is equally necessary in the preparation of more delicate objects. The powers available should vary from four to fifteen diameters. The lenses should be supported on a firm stand, so arranged as to allow of the object being viewed in various positions and, if need be, by transmitted light. A watchmaker's lens is recommended by some observers.

Researches by means of the *compound microscope* involve a tedious, though absolutely necessary, detailed investigation of the component parts of the diseased tissue already seen to differ by the naked eye. The microscopical examination, therefore, starts from what has been seen by the naked eye, and presupposes a strict observation by the latter; and it is evident that pathologico-histological research of this kind, must demand considerable time.

The requisite *aids*, in researches of this nature, are the following:

1. *Distilled water*, which, though not always, is in many cases necessary. In common spring water, several accidental impurities frequently occur, such as silicious particles, vegetable and animal remains, and living *infusoria*, &c., which may

interfere with the observation, and in investigations concerning concretions, fluids, &c., might give rise to misapprehensions.

2. *Acetic acid*, for the display of *nuclei*, as it usually renders the cell-contents and membrane transparent, whence the *nuclei* frequently appear more distinctly as granular bodies. The component cells of the horny tissue are rendered more evident. The fibrils of *connective tissue* swell to some extent, and are rendered diaphanous, the included *nuclei* consequently come into view; and the elastic fibres, especially those of smaller size, are also in this way rendered visible. The *nuclei* of newly formed or of hypertrophied organic muscular fibres, are rendered evident in their natural arrangement by this acid. It is only partially applicable to the nervous tissue. Pigment is unaltered by it; *mucin* is precipitated; colloid matter remains unchanged. Various applications of it will be found also in micro-chemical analyses. Considerably diluted, it is much used for the boiling of diseased intestinal membranes, sections of tumours and of parenchymatous organs, (for some minutes, until the parts are corrugated). The preparations thus boiled, are to be spread out and dried in order to be further examined by a method which will be described below.

3. *Sulphuric acid* is useful as a reagent—for instance, to detect the presence of carbonate of lime in concretions; on its addition to such objects, crystals of sulphate of lime are formed with the evolution of carbonic acid gas. The more solid horny tissue, hair, nails, and the enamel, are disintegrated by it into their elementary parts. When very much diluted (a few drops to the ounce of water) it forms a vehicle for the maceration of vascular parts, which should be immersed for a short time (about half an hour); when the course of the vessels may be traced. Parts also that have been macerated in dilute sulphuric acid and then dried are adapted for the making of sections.

4. *Hydrochloric acid* is occasionally useful in the investigation of morbid structural changes in the bones and teeth.

5. *Nitric acid*, much diluted, may be employed under the microscope to show the change in colour of the colouring matter of the bile, for giving a yellow colour to organic muscular fibres, the hardening of organs, &c.

6. *Phosphoric acid* is in general of little use, though, if otherwise applicable, it has the advantage over hydrochloric and nitric acids, inasmuch as it does not give off any vapour which might affect the brass mounting of the object-glass. When the latter acids are used, it is best to cover the object with a large piece of covering glass, and care should be taken to absorb any excess of acid at the edge of the glass with bibulous paper.

7. *Chromic acid*, much diluted [or a solution of bichromate of potass], may be employed for the hardening of morbid tissues in order that sections may be made.

8. *Caustic potass and soda*, or *the carbonates of those alkalies*, are extensively useful for the display of elastic tissue, of the nerve-fibres, or rather of the medullary matter contained in them, for giving transparency to connective tissue and to muscles. These reagents are also frequently employed to loosen the texture of preparations which had been treated with acids in order to display their elementary constituents, and to afford a clearer image, although for this purpose they must be much diluted. Disintegration of the horny tissue is readily obtained by their means, especially when it has been previously treated with acids, and the alkalies are then added in excess. Pigment is not changed by them unless they are much concentrated and allowed to act for some time. Coagulated *fibrin* and precipitated *albumen* are rendered hyaline by them.

9. *Ammonia* is seldom used, at any rate for microscopical purposes.

10. *Solutions of common salt, and of sugar* (a few grains to the ounce of distilled water, so as to make a solution in which the blood-corpuscles do not contract), is employed in tracing the distribution of the blood-vessels; plain water depriving the blood-corpuscles of their colouring matter. In the case, also, of very delicate or easily ruptured cells, it is advisable to employ one of these solutions, since they are injured by the imbibition of plain water.

11. *Goadby's fluid*, composed of 4 ounces salt, 2 ounces alum, 4 grains of corrosive sublimate, dissolved in two quarts of boiling water, may be employed either as a preservative agent or for the purpose of hardening tissues.

12. *Alcohol* is very valuable as a preservative agent, and also for the purpose of hardening tissues. Thin sections, also, of preparations made with alcohol and treated with acetic acid or carbonate of potass are very instructive in many respects.

13. *Æther* may be advantageously employed in thin transverse sections of preparations freed from water, owing to its reaction upon fat; but the diminished transparency caused by it is an objection to its use.

14. *Tincture of iodine* is useful, partly for the colouring of objects, partly on account of its reaction upon amylaceous granules,—as, for instance, in fæcal matters,—or upon *fungi*. The vapour of iodine is apt to obscure the object-glass, although it does not seem to exert any directly injurious effect upon the glass itself.

The *instruments* necessary for the pursuit of Histology, are few and simple. They consist of common needles and straight cataract needles, some straight and curved fine scissors, hooks, scalpels, razors, fine forceps, slips of glass, pieces of thin glass or talc for the covering of objects, fine glass tubes, a metacarpal saw with moveable blades having teeth of different degrees of fineness, several files, probes, and hair-pencils, slices of cork, &c.

In order to study the arrangement of the elements of tissues, it is above all things necessary to prepare suitable *sections*, capable of transmitting the light, and calculated either for lower or higher magnifying powers. The way in which such sections are to be made depends upon the consistence of the tissue. In the case of the more lax and pulpy textures, the most suitable instrument is a pair of fine straight scissors. In order to obtain useful sections of some length and breadth, of parenchymatous organs, such as the *liver*, *spleen*, *kidneys*, or *tumours of the skin*, &c., the double-bladed knife is to be recommended. The best form of construction of this instrument is that in which the one blade is connected firmly with the handle, and the other is affixed to it by means of two screws, one near the heel and the other at the further extremity, and by which the one blade can be more or less closely approximated to the other, whilst the parallelism between them is maintained,—which is not the case in the double-bladed knife known as Valentin's.

There are tissues, however, having only a certain degree of consistence, or of various degrees of consistence, of which it is hardly possible to make very fine, useful sections by means of the double-bladed knife, and which it is necessary should be previously hardened. The means to be employed for this purpose are, for instance, the free evaporation of the aqueous constituents—simple desiccation. With respect to which, it should be remarked that sections made for this purpose should not be more than from one to two lines thick, and that whilst they are drying they should be inclosed in paper; and that thicker portions would be destroyed by putrefaction. It is then easy, after moistening the cut surface with a drop of water to remove any undue brittleness, to procure very fine sections by means of the knife, which are then to be moistened with acetic acid, and will afford a very useful object. What kinds of pathological tissues are especially adapted for this method will be stated in the Special Part. Another and very successful method for many objects is to boil them in diluted acetic acid, in the way already described, in order to procure from them, when dried, fine sections, which are either to be simply moistened with water, or treated with a dilute solution of carbonate of soda, until their elementary parts are displayed in their natural state of aggregation. Instead of using dilute acetic acid, it is often advisable—for instance, in parenchymatous organs, such as the *spleen, liver, thyroid gland*, &c.,—to immerse them in hot water and allow it to boil for a very short time (one to two minutes). The parts coagulated by the heat, when dried or half dried, are also suitable to afford sections, which may be treated either with acetic acid alone or with acetic acid followed by soda, of course diluted.

As indurating agents, alcohol, dilute chromic and nitric acids, and Goadby's solution, have already been noticed. That they act partly by the abstraction of the watery constituents (alcohol), partly by their coagulating the protein-matter, is clear. In many cases, also, Schleiden's method of preparing sections of vegetable tissues may be usefully employed in the investigation of animal substances, as, for instance, in that of some *Entozoa*. For this purpose, the clearest and most colourless solution of gum arabic,—and very concentrated,—is prepared, in which the object to be examined is

immersed, and allowed to become thoroughly saturated with the mucilage; it is then affixed upon a little piece of wood and allowed to become perfectly dry, when some of the mucilage should be poured over it and again allowed to dry, which process is to be repeated a few times. Before it is quite dry, and before the gum has regained its pristine brittleness, suitably thin sections are taken of the object, which are to be again moistened with water when placed upon the glass-slide,—by which the gum is dissolved out, and the object completely regains its former figure.

For hard bodies, as *bones* and *teeth*, we of course employ the saw, files, a hone, and two glass plates for polishing.[1]

Of other instruments, sometimes, but not often required, may be mentioned the *compressorium*; but all the objects to be attained by such an instrument, are reached by the preparation of thin sections, or by pressure with the finger or a needle upon the covering glass.

For the purpose of estimating measurements, the glass micrometer, on account of its cheapness and greater convenience, has supplanted the costly and more inconvenient screw micrometer.

The diversities in the size of the elementary parts in pathological tissues, is frequently so great, as for instance, in the fluid of *cancer*, that no average dimension can be stated, unless very numerous measurements have been made. Again, however, there are pathological new formations, in which the size of the elementary parts does not differ much. The estimation of the dimensions of the latter, in general should not be disregarded, since, on the one hand, this is necessary for a proper understanding of the matter; and on the other, the size certainly stands in a definite relation to different conditions of nutrition, and to a varying productivity of the cells.

For ascertaining the permeability of the vessels, *injections* are important, which may be made with any coloured fluid. For preparations adapted to be viewed with a magnifying power of 50—60 diam., a very suitable material is oil of turpentine coloured with Prussian blue, or any other colouring

[1] [For the polishing of thin sections of bone, nothing is better than the use of two pieces of smooth slate, or of what is called "Water of Ayr stone," between which, the thin section is rubbed, moistened with water.—Ed.]

matter. The colouring matter must be added in sufficient quantity to afford a distinct colour when the fluid is spread out in very thin layers upon a glass plate. This is quite necessary, for otherwise the capillaries will not appear sufficiently distinct.

Injections made with size, coloured with *carmine*, have not unfrequently this disadvantage, that the material very readily transudes,—a circumstance usually owing to the too great quantity of *ammonia* added to the carmine, but which may also sometimes be ascribed to the employment of too great pressure in the injection.

It is well known that microscopical vision differs from that with the naked eye, in the circumstance that with the latter we also see the lateral surfaces of an object, which are not in the same plane; whilst with the compound microscope the image is formed on a mathematical plane, and is correct and true only when the focal distance of the object-glass is adapted to our natural visual distance. The lateral surfaces of an object, or several bodies in various planes, consequently cannot be seen without a change in the focal distance. Moreover, another important circumstance is to be regarded, viz., that in the compound microscope we usually view objects by transmitted light, and not by reflected, as is usually the case in common vision. Thus, for instance, if we place a transparent cube in a somewhat oblique position, we shall be unable, with the compound microscope, and by transmitted light, to see either the upper or the under surface at one time, without an alteration of the focal distance; nor, likewise, will the four sides be clearly shown, without a change in the focal distance proportionate to their extent.

From this theory of microscopical vision, it is obvious that considerable difficulties attend the making of observations with the microscope, and the *delineation* of microscopic objects.

For the thorough study of the morbid changes in the elementary organs and their complex relations—the art of *drawing*, is indispensable. However much we may strive to represent the forms of an object by description, we shall not succeed, with all our endeavours, to give to another a distinct representation of them, whilst we afford him at once a distinct

idea by the mere outlines of the subject. An accurate study of the outline is essential to the determination of the differences of analogous objects, and it might be said that the not retaining this figure upon paper, is a misuse of the faculty of delineation.

It is hence at once apparent, that facility in *drawing* is indispensable for the naturalist in general, but especially for the histologist. The latter should even be able to represent microscopic objects on paper, *at sight;* for in making the outline he acquires an accurate notion of the position of the object; and by partial changes of the focal distance is enabled to estimate the thickness or depth of a body: the accidental, also, will thus be distinguished from the essential, and different modifications in the mode of illumination of the object, together with various *media* must be tried, &c.

And even when the draughtsman may possess the technical apparatus of the microscope, it is very often impracticable to have it at his disposal whenever a microscopic object worth delineation is presented.

For a drawing to fulfil every requisite, its execution must be preceded by correct observation, which cannot be made except at a certain expense of time and attention. Schleiden very well says, "Whoever would observe successfully, must observe much, and with strenuous attention, by which he will soon learn that *seeing* is a difficult art." What is correctly seen should now be figured as *truly as possible;* we say as truly as possible, because an absolutely true figure is an impossibility. This brings us to consider the characters of a microscopical drawing. Just as the landscape-artist must study what contours or what combination of strokes correspond to the character of an oak or a lime tree, &c., and cannot possibly copy the detail of the branches and leaves (because by doing too much in this direction, the copy of the character will be lost), so also must the delineator of microscopical objects omit a part of the details, in order to retain the general character. It must be left to the subjective judgment to determine how much of the detail should be omitted, and in what way this deficiency is to be covered. Some degree of subjectivity therefore creeps into every figure, although the objectivity to be aimed at should never be lost sight of.

If the drawing merely represent a view derived from an abstract idea of the object, it forms a *schematic figure* or *diagram*. It represents the subjective abstraction, and is consequently of no objective worth. Nevertheless, figures of this sort are a desideratum in science, and indispensable. Only we cannot avoid remarking, that this schematic representation of all microscopic images, such as we see occasionally given, very much diminishes their objective worth and impedes the studies of the beginner, since, from them, he will hardly be able to recognise the object again in nature.

Delineation by means of the *camera lucida* and of the *disc* of Sömmering is very suitable for the laying down of outlines; but it requires considerable practice and accuracy in the regulation of the illumination, &c.

In pathological preparations especially, it is often important, to *preserve* them, as many may require future investigation and comparison; and besides, all pathological peculiarities of rare occurrence are worth preservation. The necessity and utility of a collection of pathologico-histological objects are self-evident. The preparation of these objects, however, is a more difficult matter than in the case of objects of physiological histology, inasmuch as the former occur only in the more extensive institutions devoted to pathological anatomy in such abundance as to afford the materials for a large collection.

The *means* by which microscopical preparations are preserved are various, and depend upon the object with which the preparation is connected. They may be enclosed either in the *wet* or *dry* state. In rare instances, it is sufficient simply to spread pathological objects upon a glass plate, to dry, and observe them by reflected light and under a low power. This may be done, for instance, with the minute *osteophytes* of the arachnoid, a small portion of which membrane, with the *osteophytes* seated upon it, may be cut off and spread upon a glass plate, to which, when dry, it will firmly adhere. If it be wished to examine the cut surfaces of diseased bones, or teeth, simply by reflected light, the objects may be glued upon a slip of glass, with the surface to be observed, uppermost. As an opaque cement for this purpose, a solution of asphaltum in oil of turpentine, and made of the consistence of syrup, or mastic varnish, may be employed. In preparations of this kind it is

proper to fix upon the glass slip a piece of black paper or velvet of corresponding size, with gum, so as to form a dark back-ground. To make dry preparations of objects destined to be examined by transmitted light, different methods may be pursued. Bones, teeth, and injected preparations, may be placed in resinous materials; and if it be desired to do without any covering-glass, a plan which answers well for bones and teeth, a light-coloured, clear copal- or amber varnish may be employed.

[Here follow directions for the putting up of objects in the *dry* state in Canada balsam, and their preservation in the *wet* state in cells and otherwise; but as these directions contain nothing but what will be found in several works on the microscope, in the hands or within the reach of every one, it has not been thought necessary to insert them. For full information on these subjects, the works of Mr. Quekett, Dr. Beale, Mr. Hogg, &c., should be consulted.—Ed.]

CHAPTER II.

PATHOLOGICAL CHANGES IN THE CIRCULATION. CONGESTION.

When we are viewing the circulation of the blood, it should not be forgotten that the animal is placed in altogether unusual vital conditions; and, consequently, that we cannot expect to behold the normal phenomena of the circulation for any long time. An opportunity is therefore afforded, in all experiments upon the circulation, of making pathological observations, even without any other means.

For researches of this kind, the Frog—that arch-martyr to science—affords the most convenient subject. [The mode in which the transparent membranes in various parts of the body of this animal, or in the tail of the Tadpole, are to be displayed, is too well known to require any detailed description.]

The *disturbances* which first show themselves in the circulation of the blood are manifested by the unequal movement of those corpuscles which are suspended in it; namely, the red and white blood-corpuscles. The latter, rolling along the walls of the vessel, become agglomerated into small masses, and impede the passage of the red blood-corpuscles, many of which make their way between the white granules. The latter generally exhibit a slow, to and fro movement, and are frequently seen to possess a passive quivering motion; one of them often comes into the midst of the stream, and is carried rapidly forwards for some distance, but again adheres to the wall. In the normal condition of the circulation, the red corpuscles, as is well known, move with such rapidity, that the outlines of the individual corpuscles, under a magnifying power of 120 diameters, are no longer distinguishable. The number of red corpuscles circulating in the capillaries is proportionably less than in the larger vessels. A red corpuscle frequently proceeds for a certain distance in the capillary

vessel, more rapidly than in a large neighbouring trunk. When the circulation is disturbed, the red corpuscles often pursue each other with greater rapidity, and frequently some time elapses before a single blood-corpuscle passes into an anastomosing capillary-vessel. In these cases, if a larger number of red blood-corpuscles accumulate in a vessel, they become grouped into masses, completely obstruct the *lumen* of the vessel, and at the same time, cohering together, apply themselves to the walls of the latter; whilst in the normal state of the circulatory movement they are propelled in the main stream, surrounded by a stratum of *serum* termed, perhaps incorrectly, by Valentin, the quiescent stratum, because, apparently, no motion is perceptible in the clear, colourless fluid constituting it. That the current moves more slowly at the walls than in the middle, depends upon the adhesion and attrition between the most minute parts. This condition is supposed by Valentin to be conducive to the nutritive phenomena, inasmuch as the parent *menstruum*, which affords the nutritive matters, and absorbs the compounds presented to it, creeps slowly on the porous walls, and is thus afforded more time for the performance of its functions. This stratum of *serum*, surrounding the red blood-corpuscles, is displaced when the latter become agglomerated. If only a few corpuscles cohere and become stationary, they may again be propelled by others behind them; and in this way the circulation may be restored. If the obstruction, however, be caused by a longer column of blood-corpuscles, those behind are repulsed; and in this way is caused an oscillatory movement. By this retrograde motion, it may also happen that white and red corpuscles, even in considerable numbers, are forced into another vessel, and thus re-enter the circulation. The oscillation, in a larger arterial trunk, may also depend upon the weakened impulse of the heart; for if the transparent heart of a Tadpole of a Tree-Frog, about an inch in length, be taken with the larger vessels attached, instructive observations upon this point may be made even with a magnifying power of 300 diam. By the rapid and regular contractions of the pyramidal apex of the heart, the red blood-corpuscles are not expelled from the *lumen* of the artery, but are merely propelled for a short distance, returning upon the *diastole*—which depends probably upon

the circumstance that the vessel is open and exposed to the atmospheric pressure. That the blood-corpuscles are propelled by fits and starts in the large emergent arterial-vessels, at the same time that they observe a continuous, uniform course in the returning trunks, may be seen, for instance, very distinctly in the tail of the embryo lizard.

The oscillations become weaker and weaker, ultimately cease altogether, and the *stasis* is established. The red blood-corpuscles at the same time cohere so intimately as to constitute merely a red streak. This *stasis* is usually manifested earlier in anastomosing branches, and is often fully established in the capillary ramifications of a minute artery, whilst, in a contiguous branch, the circulation is going on in a perfectly normal manner. *Stases* of this kind may be termed *local*.

Stases may also occur of merely a temporary kind, that is, which disappear again under favorable circumstances. Thus it is possible, by gentle agitation or stroking with a moist pencil, &c., to remove the local *stasis*. Wharton Jones observed that the circulation in the obstructed vessels was usually restored after a few days, when an artery was simply divided.

Dilatation of the capillaries is a phenomenon assumed by some to be constant in the condition of blood-stasis, whilst by others it is altogether doubted, or admitted to exist only to a trifling extent. With respect to this, however, it should be remembered that, in making the measurement, a given capillary must be kept in view, since those vessels, as is well known, differ in size. The measurement also should be made with a magnifying power of not less than 150 diameters; as otherwise the delicate wall of the vessel and the above-described layer of *plasma* would be overlooked, and the occupation of the site of the latter by blood-corpuscles be regarded as a dilatation of the vessel. Still more problematical than the dilatation of the capillaries is their previous *contraction*. J. Vogel says that he has always noticed it, but stating that under the influence of powerful mechanical and chemical irritation, the dilatation ensues suddenly, without any perceptible, previous contraction. F. Bidder, in his experiments, was scarcely able to induce any contraction of the capillaries, nor to establish the fact of any dilatation of them, (with which our own observation agrees); whilst he proved that a contraction of the arterial and venous trunks immediately

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contiguous to the capillaries took place to the extent of one third of their original diameter, particularly in the mesentery of the Frog; he could not perceive any dilatation of the vessels. Among more recent observers, E. Brücke has observed the contraction of the arteries in the extended membrane of the Frog's foot to which a solution of ammonia had been applied, as formerly noticed by Thomson and Kock. When he examined more closely an artery in this situation in which oscillations were manifested, he found that it is considerably contracted in the upper portion, so that, not unfrequently, a single branch filled with blood-corpuscles is thicker than the trunk from which it arises in company with several other twigs. In fact, if, previously to the experiment, he measured the arteries, at the point where they quit the toes to enter the membrane, with a glass micrometer, he found it easy to satisfy himself that the internal diameter of those which immediately supplied the portion of the capillary system experimented upon, was reduced during the development of the *stasis*, to a half or even to one third or a quarter of its original dimensions. This state of contraction and of fluctuation in these vessels, when the *stasis* was completely established, he often observed to last for a space of four or five hours. The reflections which occurred to E. Brücke with respect to this subject, are briefly as follows: "When an artery is contracted, the rapidity of the current in the branches is diminished, owing to the increased resistance, and a retardation of the stream of blood in the capillaries takes place in consequence of the contraction; a local stoppage, or even a change in the direction of the motion in certain vessels may also be produced. Consequently there is no necessity for assuming a hypothetical, primary dilatation of the minute veins and capillaries from a direct or reflex paralysis of the nerves of the vessels, in order to explain the disturbance of the circulation, as was at first stated to be the case by Henle." It should also be remarked, that the dilatation following the contraction of the arterial branch, is attended with an acceleration of the current, and that individual vessels, in consequence of this acceleration on the one side, and the impediment offered by the column of blood on the other, are exposed to a greater pressure, owing to which a *rupture* of the distended walls of the vessel may readily take place.

Wharton Jones proposed to himself to determine the influence of the *nerves* upon the contractile power of the arteries, and for this purpose divided the ischiatic nerve of a Frog, when the arteries contracted; but it appeared to him that the ensuing dilatation was more considerable than usual. Even when he divided a nervous twig accompanying the artery, dilatation ensued very speedily upon a contraction of the vessel, and this was more considerable below than above the point where the section had been made. If both nerve and vessel were divided, contraction of the walls of the vessel took place upon irritation of the natatory membrane, both above and below the wound.

Of great pathological interest, also, is the observation by the same author, that a partial, varicose dilatation of an arterial branch was attended with a retardation of the current in the dilated portion, whilst an extensive dilatation of an entire arterial trunk was accompanied with an acceleration of the circulation, owing to the diminished resistance.

From these experiments upon the irritability of small arteries it is obvious that the contraction thus induced, may cause a disturbance of the circulation, and produce a stasis within its circuit, but that it can merely be regarded as a conditional influence; and that other agencies, as for instance, the elastic contraction of the surrounding organs might, perhaps, among definite influences, be regarded as the proximate cause of the impeded circulation. With reference to this, we would notice the *stasis* which is set up in the ciliary vessels immediately after the evacuation of the aqueous humour. If the *cornea* of a white Rabbit, whose eyes, as is well known, have no pigment, be punctured with a straight cataract needle, the transparent vessels of the *iris* and the anterior ciliary vessels with their fine branches, visible only under a lens, become apparent after the escape of the aqueous humour. A reddish border is formed around the *cornea*. It might be supposed that, after the escape of the fluid, the *cornea* would appear more flattened, and lose much of its tension; but this is by no means the case, the curve of the *cornea* being scarcely affected. The *stasis* in the ciliary processes and *iris* cannot be more closely examined until the parts are removed and dissected after the death of the animal. The vascular ramifications in the ciliary

expansion and rupture of the vessels. Should the quantity of aqueous humour be more considerable, so that in fact, the *lens* and vitreous humour are not pushed forward so as to elevate the *cornea,* the diminution of the pressure would likewise be attended with minute extravasations of blood.

Phenomena of a precisely analogous kind must also accompany the evacuation of fluids from abscesses, cysts, &c. It is well known, for instance, that when abscesses are opened without the application of pressure, upon the evacuation of the *pus* some blood escapes from the cavity itself, derived from ruptures of the vessels in the walls of the abscess; the ruptures themselves being caused by the sudden diminution of pressure upon the walls of the cavity.

Another influential agent in the production of disturbances in the circulation, is *obstruction* of any kind to the *returning current of blood.* A contraction of the organic muscular layer of the minute venous trunks following the application of irritants, will effect a retardation of the current of the column of blood advancing from the capillary system; in like manner, a partial varicose dilatation of a minute venous trunk, is attended with a diminution of the current of blood within the dilated portion, and consequently may produce, secondarily, a retardation of the circulation within a certain circuit.

Local interruptions in the circulation may be the effective mechanical cause of numerous phenomena, inasmuch as the rapid increase of pressure upon the vessels of the various contiguous organs, puts a stop to the circulation through them, as it were, by a process of constriction. Thus, for instance, the rapid effusion of a serous exudation will necessarily cause a diminution of the local rapidity of the current, and, ultimately, local stases throughout a circuit wider in proportion to the extent of the effusion. In like manner, the *coagulum* resulting from the rupture of one or of several vessels, being removed from the circulation, may produce an interruption to the latter, in consequence of the unequal pressure exerted by it upon the surrounding *parenchyma* of the organ.

The *phenomena* which may arise during life, in consequence of local disturbances of the circulation, and their *significance* with respect to the whole organism, depend not only upon their extent and the organ in which they are manifested, but also,

and essentially, upon the particular part of the organ affected by them.

General interruptions of the circulation are caused by functional impediments in the organ which acts as the general mechanical motive power, viz., the heart. Thus, defects in the valves of that organ necessarily cause extensive derangements in the rhythm of the circulation. These derangements will, in general, be found to be more extensive in proportion as the disturbing cause is nearer to the heart. Thus an aneurism of the *aorta* affects the circulation more extensively than does one of the radial artery. And, in the same way, obstructions in the returning current of blood from the lungs, as for instance, in *emphysema* or *œdema* of those organs, necessarily induce a more general impediment to the circulation.

Those obstructing influences, also, which lie beyond the vascular system, and are productive of congestion, should not be disregarded; these are agencies residing in the central nervous system, and which, by their pressure, induce a paralysis of the motor nerves. Thus, for instance, interruptions of the circulation in the extremities on one side will be induced by extravasations of blood in the *corpus striatum* of the opposite side, owing to the consequent absence of the necessary periodical assistance to the circulation which is derived from the movements of the parts affected, (contraction of the voluntary muscles in locomotion, &c).

We have next to consider the *effects* of the above-described forms of disturbed circulation. It has already been shown that a contraction and dilatation of the *lumen* of the capillaries is, at any rate at present, problematical, and that their repletion with blood is due to the admission and accumulation of the red and white corpuscles in the space otherwise occupied by the blood-plasma; these are the conditions, in fact, which constitute *hyperæmia*; although, on the other hand, the dilatation of a capillary-vessel, up to a certain extent, must, *a priori*, be admitted. Now, when the blood-corpuscles have accumulated to a certain amount, they become adherent partly to the wall of the vessel, partly together, and ultimately a stagnation of the blood, otherwise in a state of continual change, is brought about. The white corpuscles, which in other circumstances roll along the wall of the vessel, adhere

to it, their number not being distinctly shown until the *hematin* is removed from the red corpuscles by water.

Under these circumstances they may be seen agglomerated into masses, though there does not seem to be any reason to suppose that their number is augmented. E. H. Weber's observation, that the white blood-corpuscles, when the circulation is interrupted, appear to be more numerous, is undoubtedly correct; but this greater number may equally well depend upon the accumulation of those already existing in the blood. Nor is there any better reason to surmise that a transformation of red corpuscles into white takes place, than there is to assume a new formation of the latter from the blood-plasma. At the same time, the possibility, or even probability, of the latter notion, which was propounded by Gerlach, cannot be absolutely denied. The supplanted blood-plasma may escape, on the one hand, through the wall of the capillary; and, on the other, may be propelled towards the venous radicle, through the opposing column of blood. The direction taken by it is determined by special circumstances; but this much is certain, that so soon as a stoppage of the circulation is set up in any part of an organ, the *endosmosis* and *exosmosis* are no longer continued under the usual conditions, when fresh blood is continually supplied, and consequently the nutritive conditions proper to the part of the organ concerned are carried on under other and unfavorable circumstances.

The stagnant blood contained in the vessel now undergoes changes, which may be studied on the great scale in aneurismal sacs, as will be more particularly noticed in the Special Part.

What changes the walls of the larger vessels undergo in their contraction and subsequent expansion are unknown. That the expansion, when it exceeds a certain amount, may cause such a diminution of the *elasticity of the walls of the vessel* as to render them incapable of contracting again beyond a certain point, after the cessation of the tension, is very probable, though, at present, the necessary experimental proof of this is wanting. If we assume that the co-efficient of the elasticity of a vessel is reduced in consequence of the interrupted circulation, it is clear that the less elastic vessel will acquire a larger lumen, proportionate to the degree of tension, to which a vessel having the normal amount of elasticity would

respond for the requisite contraction. The subsequent dilatation, whether limited to a small portion or occurring throughout a greater extent, will always produce a greater or less disturbance of the circulation, for the reasons above stated. The thin-walled veins—which, moreover, possess only a very thin layer of transverse fibres—will, on that account, the sooner lose their elasticity when subjected to too powerful or too long continued contractions and relaxations, at the same time acquiring varicose dilatations.

Upon reviewing all that has been said, it is obvious that under certain morbid conditions of the smaller arterial vessels (with dilatation in a considerable portion of a vessel) those capillaries which are supplied by them experience a more rapid change of blood (conditions which would appear to approach the nearest to what has been understood under the term "congestion"). The more active change of the blood can only result in an augmented nutrition of the organ or of the part of an organ; or, in other words, must cause its *hypertrophy*. In the propounding of this theoretical view, it is not intended to imply that the dilatation of a minute arterial trunk, throughout a considerable extent, is the only condition requisite for a more rapid circulation of the blood within a certain region. On the other hand, varicose dilatations of an arterial branch (dilatations limited to a small portion of a vessel), permanent contraction of the *lumen* of a vessel, whether owing to the contraction of the wall or consequent upon pressure from without, would retard the current, produce oscillation, and ultimately a complete *stasis* of the blood; whilst the incomplete interchange, or the entire deprivation of the nutrient blood-plasma, would cause a diminution or complete interruption of the nutrition; or, in other words, would induce an *atrophy* of the part affected, in all its manifold varieties. Hypertrophy and atrophy, as is well known, are often combined—as, for instance, in the sebaceous follicles of the skin—under particular circumstances. If the transverse section of one or two arterial branches be greater than that of the other, it will, of course admit a larger quantity of blood; but in the same proportion must the calibre of the second branch undergo diminution, if both be supplied by a common trunk, whose size remains unaltered.

It is hardly possible to determine the *limits* within which the increased amount of blood-corpuscles in any particular organ ceases to constitute a physiological condition and passes in the pathological. It is well known that there are certain organs which periodically admit a larger quantity of blood-corpuscles, or, in other words, become congested,—as is the case with the mucous membrane of the stomach during the process of chymification, or in the sexual organs and their appendages, in many animals, during the period of "heat." The same thing occurs in repeated, rapidly succeeding contractions of the muscles of the extremities, and of the diaphragm, in increased transpiration from the skin in a more elevated temperature, in the more rapid and vigorous contractions of the heart in running &c.; and we cannot regard this *hyperæmic* or congested condition, as it is termed, as *morbid*,—that term implying a more prolonged and more frequently recurring disturbance of the circulation, resulting in a modification of the nutritive condition of the organ.

It is a well known fact that the nutrition of an organ is carried on by the endosmotic action of the smallest blood-vessels, and that the nutrient fluid transudes through those vessels; and consequently it further follows, that a certain part must exude whilst another enters and is mixed with that portion of the blood which does not exude. Nutrition consequently consists in the supply from the blood, of the materials required for the maintenance of an organ, in exchange for those which are no longer applicable to that purpose. Now when a *stasis* is set up, the latter are no longer conveyed away, and the transudation will take place under other conditions than those which obtain when the circulation is at its normal speed; it becomes a *pathological transudation, and the physiological cytoblastema assumes the character of a pathological exudation.* Various endeavours have been made to determine the point of time at which this change takes place; and it has generally been admitted, that it does not occur until after a *stasis* has been established. That this view, however, is a scholastic one, is at once obvious, because there is no reason to suppose that the transudation may not take place during the whole period that the disturbance of the circulation exists, since it must be admitted that it is always going on in the normal condition of

the circulation. We cannot trace the act of transudation with our eyes, because the transuding fluid is transparent; and are consequently only able to observe the exudation when it makes its appearance on the surface of membranes; and it is this appearance alone that can inform us that we have to do with a *process of exudation*, or an *inflammation*. If the exudation has undergone no morphological changes recognizable under the microscope, it constitutes nothing more than a hyaline, structureless material, and is therefore not a subject for microscopical observation. It is possible, perhaps, to render it a microscopical object, by precipitation by means of heat, or other reagents, or, by evaporation, to render the mineral constituents visible. But in doing this many difficulties stand in the way, which may at once be indicated by an instance. If we examine the kidneys of a person who has suffered from *albuminuria*, and died within twenty-four hours with symptoms of *stupor* and *dropsy*, we shall in many cases be puzzled to specify any pathological, anatomical changes, and shall be compelled to allow that these are unsatisfactory. We shall in like manner hesitate, when we examine the spinal chord of a tetanic subject, and endeavour to satisfy ourselves of distinct pathologico-histological appearances. These negative results, however, should not deter us, and we must look about for other methods, by means of which we may perhaps be enabled to arrive at a distinct exposition of the pathological changes. In no case should we be justified in wholly denying the existence of a hyaline exudation in the parenchyma of the organ.

It is a fact universally recognized, that in all exudations the product is at first a limpid fluid, which does not become viscid and turbid until afterwards. The turbidity of the exudation, moreover, does not reside in itself as such, but is usually due to the development of new elements. Thus in *variola* we observe the fluid contained in the vesicles, which is at first transparent, to become turbid—but this change is caused by newly formed elements, viz., by pus-corpuscles.

The *time* in which exudations are formed, depends in general upon their consistence; the more limpid the exudation, the more rapidly may it be formed. Theoretically there is no reason, as has been shown above, against the supposition that

the limpid exudation may be afforded by the still circulating blood before the *stasis* has become established.

We shall be inclined to regard this view as correct, if we consider the cases in which an exudation is observed to take place with extreme rapidity—frequently within a few seconds—as in the bites of insects, burns, &c., more especially in those parts of the skin where the *epidermis* is very thin, or as the effect of various noxious substances upon the mucous membrane of the eye, the tongue or the lips.

Exudations present great variety in their external form; and they may be brought into different categories according to their consistence, colour, and chemical and histological conditions.

In a physiological point of view, also, they may be arranged in two large groups, one of which would include those exudations which are capable, to a greater or less extent, of undergoing development into new elements—or the *organizable*; and the other, those effusions which do not exhibit such a capacity for organization—or the *unorganizable*. In a chemical point of view, according to Lehmann, no classification of them can be made simply from the predominance of one constituent or another, since no definite limits, in that respect, whatever can be drawn; and the absolute deficiency of any given constituent itself cannot be proved even in any particular instance. But the anatomist and physician require a scheme, which, it must be confessed, will not serve as a strictly scientific classification.

1. The exudations may be quite limited, exhibiting no histological elements at all, or but very few accidentally mixed with and suspended in them; these exudations will be termed the *simple serous* or *hydropic*. They may be obtained in considerable purity from the larger visceral cavities, or from cysts; but in the parenchymatous organs,—as, for instance, the lungs,—or in the skin, they are often mixed with several other elements. The fluid is yellowish or greenish-yellow, clear, and transparent; and, according to several analyses by J. Vogel, contains elements identical with those found in the serum of the blood: that is to say, water, organic matters, including albumen in solution, fat, extractive matter (occasionally, also, small quantities of *urea*, *bilofulvin*, and

hæmatin), together with various salts (mostly carbonates?), alkaline and earthy phosphates, and metallic chlorides. Serous exudations not unfrequently appear turbid from the admixture of free fat, forming a sort of emulsion with the albumen; a slight increase in the amount of protein compounds in the fluid will render it mucoid and tenacious. An opalescent film not unfrequently forms on the surface of the fluid, consisting of *cholesterin.*

The frequent instances in which, owing to compression, the return of the blood in the less resistant veins is impeded,—such as takes place, for example, during pregnancy by the distended *uterus*, or in consequence of the pressure of a tumour, of a cyst filled with exudation, or of the enlargement of an infiltrated parenchymatous portion of tissue,—justify the conjectural opinion of J. Vogel that the serous effusion is afforded from the veins, and that it takes place whenever a disproportion arises between the porosity of the venous walls and the density of the blood contained in them; so that either the walls of the veins become more porous or the blood thinner and more watery than in the normal condition. In either case, there ensues an increased transudation of the blood-serum through the walls of the vessel. Another cause of dropsy is referred by J. Vogel to a change, and more particularly to a thinning, of the blood. In support of this view, he relies upon the more recent experiments of Magendie, which tend to show that after defibrination of the blood, and after the injection of a considerable quantity of water into the vessels (especially in Rabbits), dropsical effusions take place.

2. Another kind of exudation is characterised by the presence of *fibrin*, which is contained in the exudation in the liquid state, and coagulates like the fibrin of the blood; it possesses, also, the same morphological character, exhibiting the aspect of a very delicate, intricately interlaced, filamentary network. These exudations will be termed *fibrino-serous* or *fibrino-dropsical.* In their chemical composition, this fluid, according to Vogel, precisely resembles the blood-plasma,—that is to say, the fluid part of the blood without the corpuscles; it is blood-serum, the fluid of serous dropsy holding *fibrin* in solution. Chemical analysis shows the presence in it, of water, organic elements—such as fluid *fibrin*, albumen, fat, extractive matter, and salts.

This correspondence of the fluid with the blood-plasma, in rare cases, extends also to the quantity of the individual elements, though it usually contains more water than the latter, and less of the organic elements, and, in particular, less albumen and *fibrin;* it is only in very rare instances that it presents a greater abundance of these elements than is contained in the blood-plasma. According to the same author, it may with great probability be assumed, that in these fibrinous effusions, the fluid part of the blood escapes through the walls of the capillary vessels; whilst, as we have seen above, in the serous form, the fluid part of the blood probably transudes through the walls of the veins. The agreement of all experiments on this subject indicates that the endosmotic product of the veins is thinner and poorer in organic elements than that afforded by the capillaries. It is not to be wondered at, that, in our complete ignorance of the endosmotic conditions of the vessels, we are unable to arrive at any positive conclusion with respect to this point. The subtle questions thence arising can be satisfactorily answered, in some measure, only by experiment. Experiments upon the endosmotic properties of thicker and thinner vessels, filled with various fluids, at different temperatures, must be instituted; and in addition to this a varying pressure by means of a column of fluid should be applied,—nearly that of the column of blood; and the vessels of individuals of various ages must be compared, as should also healthy and diseased vessels, &c. For the solution of the question, as to the influence of the rapidity of the current upon the endosmotic conditions, a determinate quantity of fluid might be propelled through a porous vessel in a given time, and under a determinate pressure. It should also be ascertained how the rapidity of the current, modified by the curvatures of the tube, and by the various modes of division of the lateral branches, &c., affects the endosmotic conditions. The importance of experiments of this kind, both physiologically with respect to nutrition, as also pathologically, for the establishment of the physical theorems concerned in exudation, imperfect nutrition, &c., is so great, that we have been thus induced to dwell upon it.

To return now, to our modified, dropsical effusion, or fibrino-serous exudation. This exudation, if the aqueous constituent

does not fall below a certain minimum, will remain unorganizable; but when the proportion of the watery element is so far diminished that the exudation ceases to be a thin fluid, it is then rendered capable of becoming organized, unless other impeding circumstances intervene, with which it must be confessed we are but very imperfectly acquainted. It appears that the *fibrin* plays an important part in the *organizability*, although there are other secondary requirements for this, which we shall endeavour in some measure to elucidate in the course of the work. Lehmann doubts the correctness of Vogel's opinion, that it is only exudations containing *fibrin* that are plastic, that is, which are capable of developing *cells* and *tissues*. He believes that in the organization of the exudation, the *fibrin* continues to be formed out of the albumen of the transuded plasma, but that it is rapidly again metamorphosed, because the *fibrin* in general is to be regarded as an intermediate link, as a transitionary stage in the metamorphoses of the nitrogenous substances. From these brief observations it is obvious that the organizable exudations cannot be distinguished from the unorganizable, but that the two forms pass into one another.

The *fibrinous exudation* is characterised by its containing a greater abundance of fibrin. Now, as the latter occurs in exudation in both the semifluid and coagulated states, we might in an anatomical sense, distinguish a *semifluid* or *gelatinous*, and a *coagulated* fibrinous exudation; and at the same time, it is at once apparent, that the latter must be secreted in the fluid condition. The distinguishing characteristic of the fluid *fibrin*, as is well known, is its spontaneous coagulability, when removed from the vital influence. "With respect to the causes of this coagulation," says Schlossberger, "the most various hypotheses have been propounded since the time of Hippocrates, without our having arrived at any satisfactory explanation of them. We have gradually become acquainted with a variety of substances, some of which hasten and others retard the coagulation; but with all these experiments we have not advanced a step towards the proper solution of the question, as to why the *fibrin*, which is naturally in solution, should be spontaneously coagulable. Under certain circumstances, the coagulation is very much retarded, in the blood, in exudations,

and in other fibrinous fluids; but we are still very much in the dark with respect to this, frequently remarkable, modification of the most important property of dissolved *fibrin*, and it must be left to futurity to determine, whether, in these cases the *fibrin* has itself undergone modifications, or whether this retarded coagulation is the consequence of foreign admixture, of various degrees of dilution, or of other external influences."

Fibrin, whilst in a state of solution, cannot be made the subject of histological observation, but when, in combination with other elements, in the form of fluid, fibrinous exudation, its organization has commenced, its state of aggregation changes; it becomes in certain parts more consistent; the viscous consistence becomes gelatinous; the uniform yellowish colour is replaced in parts by a whitish speckled hue; the transparency is diminished in those portions, which, by reflected light, appear as white points and filaments; and in these situations, under more powerful magnifying powers, we may observe newly developed elements which are wanting in the transparent parts. The newly developed elements, in the different forms of exudation, present very great variety, and it has even been attempted to denominate *exudations from their predominant elementary constituents*. Thus we speak of purulent, ichorous, cancerous, tuberculous exudations, &c. Properly speaking, these denominations are illogical, because the fluid fibrinous exudation, is in fact nothing else than a formative material, a *blastema*, an amorphous substance from which the various kinds of elements are not till afterwards developed; we cannot, therefore, name the exudation from something which does not really exist in it so long as it is an exudation; but when new elementary parts have been developed, it has ceased to be a simple *exudation*, and has become metamorphosed into a *new formation*. Nor, again, in strict terms, can we speak of a hemorrhagic exudation, for an exudation cannot take place from a ruptured vessel; under this term, therefore, can merely be understood an exudation associated with an accidental hemorrhage.

A question connected with this subject, and which, on account of its importance, has been raised by many persons, is this: whether any given exudation possess a determinate organizability, that is, say, for instance, whether an exudation,

by virtue of its innate properties, may in its organic metamorphosis, merely reach an imperfect cell-formation; whilst a second, destined to undergo a higher organic expansion, is transformed into cells of various degrees of development; and a third merely attains to the production of homologous elementary constituents. The affirmative answer to this question would imply an independent specialty in each exudation, and the matter would of necessity have to be regarded in the same light as the case of the impregnated *ovum*. Just as in that case, from an apparently homogeneous substance, so many kinds of tissue arise whose development is continued according to a determinate type in each animal, so also would the structureless fluid exudation possess an innate tendency to assume only a definite form of organization; and thus, one exudation would be capable of being transformed only into pus, a second into tubercular matter, and a third into cancerous matter, &c. J. Vogel is of opinion that the question whether a given *cytoblastema* possesses merely the general property of becoming developed, or whether it has a tendency to become developed into a particular tissue, cannot at present be definitively answered; but there are very strong grounds for believing that the nature of the tissue subsequently produced does not depend upon the constitution of the *blastema*, but upon subsequent external influences. He was never able to detect any morphological or chemical difference between the *cytoblastema* of tubercle, scirrhus, pus, connective tissue, &c. And experiments on the subject of inflammation prove distinctly that an exudation (*blastema*) of the same morphological and chemical properties, and derived from the same source, may, under different conditions, give rise to tissues of the most diverse kinds. The answer to this highly important but difficult question can only be arrived at by the way of observation and experiment. Let us seek the aid of the former, and consider various exudative processes in their origin, course, and result. In *variola*, for instance, the exudation is a local deposit, confined to circumscribed parts in the *corium* and on its surface; the *epidermis* is elevated by the exudation collected beneath it, into the form of a hemispherical vesicle; pus-corpuscles then arise in the fluid, which multiply to a certain extent; the aqueous part of the pus is removed, and the vesicle dries up, and so on.

This process, therefore, which is repeated so many times in the same individual, and takes place in so many with unvarying uniformity, presents in the form of development of its exudation such a stability that it is impossible to escape the conclusion that the exudation poured out in *variola* possesses a tendency to become developed into *pus*. It is evident that this development may be interrupted by various circumstances. Again, if we examine the exudation which is poured out into the *corium* in *scarlatina* or in *rubeola*, we shall also notice constant peculiarities in the mode of deposition, in the consequent detachment of the cuticle, and in the non-development of the exudation into elementary organs. But although we derive little assistance from chemistry or the microscope in the case either of these or of other exudations in which the investigation is more readily made, still we should not absolutely deny the specific nature of an exudation; as the negative results at which only we have at present arrived, may simply be owing to the coarseness of our methods of research. It is even very possible that our balances are not, at present, delicate enough to estimate such minute quantitative differences between the elements in various exudations, with respect to the proportion of the protein-compounds to the aqueous medium, salts, &c. Our knowledge, also, of the products of the decomposition of the protein-compounds is still very defective, although they promise to afford some conclusive evidence as to the capability for organization of the exudation. The micro-chemical investigation, also, of this subject, still requires great attention.

The specific organizability of an exudation also depends without doubt, *upon the situation* in which it is deposited. If it take place, for instance, between the ends of a fractured bone, osseous substance is again developed from it, whilst incised wounds in the connective tissue are united by an exudation which becomes organized into connective tissue. Newly formed cancerous deposits are modified in the type of their conformation, at any rate to a great extent, according to their situation, as will be afterwards more particularly shown.

Lastly, as regards the organizability of the exudation, an unknown quantity must be considered—the *vital factor*.

Experiments as to the possibility of limiting or of promoting the capacity for organization of an exudation under the vital

influence, and of determining the necessary conditions under which the one or the other may take place, are every day performed by the practising physician. When he employs caustic to destroy the newly-formed connective tissue on the surface of an ulcer, or the pus-corpuscles, or newly developed connective tissue elements on the surface of a mucous membrane, his aim is to prevent the multiplication of the newly formed elements. When he unites the edges of a wound by sutures, and endeavours to obtain its closure by rest, proper position, and temperature, &c., his object is to provide against the newly formed connective tissue elements being impeded in their development by any external circumstances. But the cardinal question lies in this—whether as an experimenter he is in a condition, by a certain change of the external influences, so to alter the organizability of the exudation, that its tendency to become developed into a determinate tissue shall be perverted. When all the circumstances *pro* and *contra* are duly weighed, it would seem to us rather to be the case, that he is *not* able to induce a transformation of the kind in question by a change in the external conditions, and consequently, that he must be content with the power of limiting or destroying the organization of an exudation, or of obviating all those circumstances which may impede its development or removal in one way or another. This opinion is merely broached hypothetically, as we are unable at present to adduce any positive proofs in its favour.

The forms of the *coagulated fibrinous exudation*, are extraordinarily various, and divers transitionary stages may be observed in the same individual. The colour is white, whitish-yellow, greyish, yellow, yellowish-red, yellowish-brown, or brownish-red; the consistence soft and doughy, elastic or tough, dense, or even as hard as cartilage. The form assumed by the *fibrin* in coagulating, depends in great measure upon the circumstance, whether it coagulate tumultuously in entire masses, or more slowly in smaller particles; just as salts in solution may crystallize in various forms, according to the concentration, temperature, quiescence, surface, &c., of the menstruum which holds the mineral substances in a state of solution. It assumes, therefore, the aspect of *flocculi*, little masses, fine filaments, plates, more or less consistent coils, and flakes. The trans-

parency is of course lost upon the coagulation taking place, being the more completely destroyed the more closely the fibrinous *coagula* are aggregated, and the less the amount of protein compounds still remaining in solution between the already coagulated fibrinous material. The *elementary form* of the latter we will now proceed to consider more attentively.

There are certain structureless hyaline plates having no defined fundamental form, of various dimensions, to which, as occurring in the blood, Nasse first assigned the name of "*fibrinous flakes*." The possibility of confounding these with old epidermis-cells accidentally present, was shown by C. Bruch, but such a mistake can only arise when the characters of the old epidermis-cells as plicated, flattened corpuscles, containing delicate molecules, of a definite size, and often retaining a manifest *nucleus*, are disregarded. We consider the existence of flake-like bodies in blood withdrawn from the circulation as placed beyond all dispute, only doubting whether they be *fibrin*, regarding it as more probable that they are of a colloid nature, since they are not farther altered by acetic acid. The *filamentary form*, affords the only certain morphological character of coagulated *fibrin*.

The filaments constitute a delicate interlacement, and may be seen hanging separately, and never aggregated into bundles, at the edge of the preparation; they resemble a fine elastic network of filaments with numerous free interstices filled with a hyaline fluid. If the coagulated *fibrin* be treated with alkalies, it is rendered transparent and gelatinous, and is then deprived of its coagulability. Schlossberger proposes the question, whether under these circumstances it is not changed into albumen, induced by the remarkable discovery of Liebig, that albumen may be produced from the *fibrin* of the blood. If well washed *fibrin* be covered with water and left to itself in a close vessel in a warm situation, putrefaction soon commences, and at the end of about three weeks almost all the *fibrin* is resolved into albumen, as can be demonstrated in the filtered fluid. In acetic acid, also, coagulated *fibrin* becomes gelatinous and swells up. The molecular form of coagulated *fibrin* is now described but by few chemists as more than a particular state of aggregation (molecular *fibrin*); and both this and the flaky form have been declared by Lehmann not to be any form of coagulated *fibrin*.

The organizability of the coagulated fibrinous exudation is in general trifling, and may occasionally be wholly wanting. The newly developed elements are limited to a few, and often imperfectly developed forms; as for instance, pus-corpuscles, large granular cells, groups of roundish *nuclei* imbedded in a molecular substance, or solitary and elongated, which are not apparent until the fibrinous mass has been rendered transparent by acetic acid, &c.; as will be afterwards more particularly adverted to.

Various authors have classified the fibrinous exudations in different categories, according to their consistence, their effects, and the elementary parts contained in them. Thus Rokitansky distinguishes a *simple* or *plastic*, fibrinous exudation, corresponding to what is termed by us, the fluid fibrinous exudation, and a *croupose* corresponding to our coagulated fibrinous exudation. The latter, according to him, has either a great tendency to liquefy into pus, or is dissolved more rapidly without any well marked formation of *pus*, and exerts a corrosive, solvent influence upon the *substrata*. It consists, as he states, besides an amorphous *matrix*, of nuclear and cell-formations. His third form of croupose exudation is characterised by the solidity of the product, and its tendency to become rapidly disintegrated, when the tissues are resolved into a fetid, ichorous, pulp, or into a viscid, tenacious, spongy, soft slough. J. Engel distinguishes a soft, solid, and a gelatinous exudation —fibrin; and Henle describes three principal forms of fibrinous *coagula*—the flocculent, gelatinous and fibrous.

The *albuminous exudation* is characterised by its containing a considerable proportion of albumen. It is yellowish, yellowish-red from the admixture of blood-corpuscles, transparent or milky from elements suspended in it, sometimes a thin fluid, sometimes viscous, stringy and tenacious. It does not coagulate spontaneously, but only after the addition of the same reagents as are usually employed for the coagulation of albumen, viz.—heat (between 55° and 75°), nitric acid, corrosive sublimate, &c. and it is not till then that it exhibits under the microscope a very fine molecular substance, whilst in the fluid condition it of course presents no elementary forms. To ascertain the organizability of this exudation, is the more difficult because it occurs so frequently complicated with the fibrinous, and because

it is well known, that chemistry as yet possesses no certain means of distinguishing coagulated *fibrin* from coagulated albumen. Consequently we are not in a condition, in case we have to do with a protein-compound coagulated during life, to say with certainty which of the two bodies above mentioned it may be.

With respect to the origin of this exudation, C. Schmidt has ascertained the most important fact, that the albuminous admixture contained in a transudation is derived from the capillary system, through which the transudation has taken place, a statement which he has also supported by several careful parallel and simultaneous examinations of normal and morbid transudations. Schmidt assumes for each group of capillaries a determined and constant quantity of albuminous contents in the transudation. He found that transudations into the *pleura* were the richest in albumen (=2·85%), those into the *peritoneum* containing considerably less (=1·13%), whilst still less was contained in those of the arachnoid (0·6 at most 0·8%), but the smallest quantity existed in effusion into the subcutaneous cellular tissue (=0·36%). He found the same proportions to obtain in an individual who had suffered under 'Bright's disease;' and satisfied himself by farther researches into the normal transudation of the cerebral capillaries and into hydrocephalic effusions, that not only where the transudation is excessive do the albuminous contents in the transudation always remain pretty much the same, but also when, after the removal of the older transudation, a new effusion is poured out from the same capillaries.

Exudations containing colloid, we have thought, with Förster, should be described as of a distinct kind, although hitherto no certain re-agents are known for their discrimination. It is well known that there are certain exudations, which are deposited, especially in cysts, and the dilated areolar spaces of the neighbouring parts—for instance, in the enlarged thyroid gland, appearing as transparent, glutinous, yellowish masses not unlike liquid glue, which under the influence of hot water, coagulate into a sort of jelly, although at the same time retaining their transparency. Treated with water, they exhibit the same appearance as glue which has solidified in small portions upon a piece of glass, and which has been broken into small bits, and moistened with water. The colloid sub-

stance is also met with in a more compact form. There occur, for instance, not unfrequently, on the walls of the large cysts of the thyroid gland, and on the *pleura*, little greyish-white masses, closely resembling the flakes above noticed, and which are not affected by acetic acid or very dilute alkalies. A frequent form, also met with, associated with the above, are, sometimes smaller, sometimes larger, flattened, smooth, or concentrically laminated bodies. Their more particular description must be reserved for the Special Part, since they are met with in many organs in very marked and characteristic forms. It will be sufficient here to remark, that they are to be regarded as a form of solidified colloid, and might be designated *laminated colloid corpuscles.* They have been described and figured by Kölliker and Virchow, under the name of *corpuscula amylacea.* Hassall has termed the bodies which are found very frequently in the prostate, prostatic concretions or *calculi.* They have also been described by Henle under the name of *corpora Hassalliana.* This exudation possesses a low grade of organizability, inasmuch as the flattened cells which multiply by division, are usually soon impeded in their development by the colloid medium; and thus arise various kinds of formations, which will be afterwards described more particularly. It may even happen that elementary parts belonging to the parenchyma of an organ, or others, which may be regarded as of new formation, are enclosed in the colloid deposit, whence arise tissues of which a variety of explanations have been given.

The forms of exudation above enumerated are to be looked upon, as it were, in the light of fundamental types; and the combinations and variations of which they are capable are innumerable, and are met with not only in various exudative processes in different organs and individuals, but, upon careful examination, may be noticed in the course of one process in the same organ. Our present doctrine with respect to exudation is but a very poor crutch, upon which we must hobble for a time, in order in some degree to obtain a measure of the ground we have to survey. Above all is it requisite to submit to an exact examination the exudations of animals in the most recent possible condition; for in the human subject, owing to the time which necessarily elapses before they can be examined,

they have undergone numerous changes; and those exudations which we obtain from the surface of the living human body, are in many respects insufficient for the purpose in view.

Another, more disadvantageous, circumstance opposed to an accurate chemical investigation, is the fact that the exudations are often mixed with other structural elements; and we are consequently frequently puzzled to say what should be referred to the exudation, and what to the original structural tissue of the organ.

The *unorganizable exudations,* under favorable circumstances, undergo a retrograde process, which has been termed *retrograde metamorphosis,* or *involution.* But the organizable effusions may also, under particular circumstances, be impeded in their development from the very first, and may present the phenomena of involution without their having undergone any, or a very imperfect organization.

For the *resorption* of an exudation to take place, its elements must be in the fluid condition; consequently, the solid constituents remain, if incapable of becoming fluid. This fluidity is caused by a new exudation termed 'solvent,' by J. Engel. The changes undergone by the protein compounds in this process are unknown to us. The structural parts which more especially participate in this act are the minute venous trunks, and the lymphatics, which in many situations are still problematical. The possibility of a resorption must depend upon the excited circulation around the liquefied exudation, in consequence of which the equilibrium between the *plus* and *minus* of the fluid constituents in the contiguous parts of the tissue is restored. The practitioner endeavours to establish this possibility by local or general excitants of the circulation, or even by simply attempting to remove the obstacles to a free circulation. In this way the resorption may ensue either partially or entirely.

If a portion of the exudation incapable of being absorbed be left, this remainder of the solid and partly fluid organic substance is metamorphosed in various ways. Sometimes it constitutes a flaky or stringy, sometimes a finely molecular substance, which when it forms thicker layers assumes a brownish-yellow colour. This kind of retrogression of the exudation has been termed *obsolescence, shrivelling* (*Verschrümp-*

fung), and *tuberculization*. The deposition of *pigment* takes place in exudations which have undergone involution, in the form of aggregations of orange-yellow, reddish-brown, or brownish-black molecules, which sometimes seem to be united by a connective substance, in such a manner as to appear like black specks under the microscope. The pigment is most probably derived from the colouring matter of the blood, which, upon the disintegration of the blood-corpuscles, transudes through the walls of the vessels in the fluid state, and subsequently assumes the solid form. It may also without doubt be formed from the defunct blood-corpuscles, both within the uninjured vessels, in the case of stagnation, as well as without them, in the extravasated blood-corpuscles,[1] the colouring matter held in solution in the red corpuscles being precipitated in their interior. The special proofs of this proposition cannot be given here.

The protein-bodies in the exudations, when removed from the direct vital influence, frequently present an *accumulation of fat*, which is termed a fatty metamorphosis or degeneration. In fatty exudations of this nature, we perceive a large number of fat-globules of various dimensions, floating on the surface of the preparation when moistened with water. The size of these globules diminishes down to that of a barely-perceptible molecule, but which, when properly focussed, exhibits a brilliant appearance. The fat-globules are frequently aggregated into larger or smaller granular masses, or occupy a considerable space. The exudation, in consequence of this, loses its transparency, and presents, by reflected light, a whitish-yellow or dirty-grey aspect. The fatty degeneration often extends uniformly throughout, but is more frequently observed in many places in the retrograding exudation in considerable quantity, and is by no means always connected with a loosening of the tissue, as has been sometimes asserted. That this deposit really is of a fatty nature, is demonstrated by the use of ether. Treatment of the preparation with acetic or hydrochloric acid prevents any confounding of the finely divided fatty matter with carbonate or phosphate of lime, or with urate of ammonia.

Fatty degeneration may also occur in an organizable exuda-

[1] [*Vide* a Case recorded by J. Vogel, 'Pathol. Anatomy' (English translation), p. 194, and observations on Pigment generally, ibid., p. 189-196.—Ed.]

tion, in the course of its organic development; the contents of the newly formed elementary constituents undergoing the same metamorphosis, and their further development being stopped. We shall afterwards return to this most important subject in greater detail.

The question as to the mode in which this transformation of the protein compounds into fat takes place, is one of the greatest interest; but it is to be regretted, that at present we are unacquainted either with the mode of transformation, or with its products in general.

If numerous inorganic constituents exist in an exudation undergoing involution, they are precipitated in the organic basis, giving it a greater degree of hardness and fragility. The principal mineral constituents occurring under these circumstances are carbonate and phosphate of lime; and the process of their deposition, consequently, has been termed *cretification*, a term which is to be preferred to that of *ossification*, which is sometimes applied, since a new formation of osseous substance in exudations of this kind does not take place. Cretification is characterised by amorphous opaque masses, deposited for the most part in groups in the organic matrix, and which are best brought into view in thin sections. The carbonate of lime, in particular, often assumes the form of considerable sized, grouped granules. In the microscopic analysis of these deposits, it is always requisite to employ acids as reagents,—of which the most useful are the acetic, hydrochloric, and sulphuric. The inorganic constituents, again, may exist in such abundance, as almost to displace the organic; —of which the small quantity of coal on heated platinum-foil affords satisfactory evidence. Retrograding exudations of this kind, with a preponderance of mineral constituents, pass into concretions and *calculi;* in which it not unfrequently happens, when forming in the intestinal canal, urinary bladder, &c., that other accidental products may be inclosed.

The highest degree of retrograde metamorphosis is the *putrefaction* of the exudation, or its *gangrene*, which is brought about by means of the products of the *decomposition* of the protein compounds. The characteristic of a gangrenous exudation consists in the circumstance that, in consequence of the putrefactive decomposition, the subjacent tissues, in a comparatively

short time, and for a considerable extent, also die; a similar process of decomposition being set up in them. A peculiar mawkish odour is given off under these circumstances. The texture of the tissue is broken up, it becomes discoloured, dirty reddish-brown, or of a dirty gray colour, and is transformed into a softish pultaceous mass. The *dry gangrene*, which is caused by a sudden and permanent interruption of the circulation, and is, therefore, unconnected with a rapidly decomposing exudation, does not belong to the same category. But since, in consequence of the peculiar putrefaction of the dead portion, a process similar to the moist gangrene is excited in the sound tissues, it may be mentioned in this place. The histological characters of the gangrenous exudation are limited to its disintegration into a fine molecular substance and fat-drops. The surrounding tissues are transformed into an amorphous mass; a change which is more marked in proportion to their less powers of resistance to chemical decomposition. The stronger elastic fibres, therefore, especially, may be very readily observed, when the fibrils of connective tissue have already undergone decomposition. According to Vogel, the transverse *striæ* of the muscular fibres disappear, the latter being rendered pale throughout, transparent, and gelatinous. Black or reddish-brown corpuscles of indeterminate form occur very frequently, termed, by the same author, "melanotic granules."

The gangrene of the exudation is a necessary consequence of a diminution, to the lowest possible degree, of the vitality of the organ affected. The blood, stagnating in the vessels, is speedily decomposed, the corpuscles are dissolved, the delicate vessels perish, and the infiltrated tissue is more or less destroyed by the products of decomposition of the protein compounds, with which we are unacquainted. This decomposition proceeds the mo[illegible]pidly in proportion to the degree of diminution of the [illegible]y of the whole organism.

[illegible]e is cau[illegible] it were, by a cutting off of the ar[illegible]ted fr[illegible]st of the organism by *coagula* [illegible]ued in [illegible], according to Rokitansky, may [illegible] with [illegible] of organic substances,—that is [illegible] the d[illegible]nt upon the total deficiency or [illegible] with separation of carbon.

Various attempts have been made to determine the *causes* of the *diversity* presented by *exudations*, in their external habit and chemical relations; and, as the exudations are a product of the blood, endeavours have necessarily been made to ascertain the pathological changes in the latter. From these inquiries has arisen the doctrine of *blood-crases*.

The blood, as a nutritive fluid, must, as regards its condition, depend upon all those agencies which affect its preparation in a direct or indirect manner. These agencies may undergo various modifications, without any transgression of the limits of health. It is, consequently, in many cases, difficult to determine whether we have to do with blood simply modified within the limits of health by special circumstances, or in a pathological state. The simple physical changes of the blood in themselves are not sufficient to enable us to decide upon the morbid condition, because a multitude of circumstances may induce them. For instance, it depends upon circumstances with which we are unacquainted in all their bearings, whether the *fibrin* in the vessels coagulate more or less rapidly, and whether it assume one or another form in coagulating. In considering the subject of *crases*, therefore, we can only decide upon chemical grounds, and regard the physical phenomena of the blood, in the living as well as in the dead subject, simply as the starting-point of our inquiries.

The pathological changes of the blood may be divided into *two categories*. The quantitative proportion of the normal constituents of the blood may be so far changed, that an essential preponderance of the one or the other element will be apparent; or constituents may be superadded which do not exist either at all or only occasionally in the normal blood. To the former category belong:

1. *An increase of fibrin* (Simon's *hyperinosis*), which has been observed especially after inflammation, with a simultaneous diminution of the red, and an increase of the white corpuscles of the blood (?). It has been stated by many, without sufficient reason, to be a primary lesion of the blood, whilst it may just as well be regarded as the *effect* of the inflammation. The existence of such a *crasis*, therefore, remains problematical, until by experiments in animals it shall have been shown, that by the introduction of determinate conditions an increase of

the quantity of *fibrin* in the blood may be produced, before the setting in of an inflammatory action. Lehmann's observation, also, is of importance, viz.: that non-febrile inflammations do not cause any augmentation of the quantity of *fibrin* in the blood, any more than does simple fever without inflammation. The explanation of the increase of *fibrin* after inflammation, and the question as to whether it may arise from the transformation of another protein compound into *fibrin*, of a kind admitting of chemical demonstration, have likewise not yet been afforded or answered. The fibrinous exudations proceeding from this problematical crasis might also be the product of a merely local cause of inflammation. A diminution of the *fibrin* in the blood, as a constant phenomenon in any disease, has not been proved with certainty; and in cases where such a diminution has been met with, it has always been inconsiderable.[1]

2. *Increase of albumen* (Simon's *hypinosis, albuminosis*), with diminution of the *fibrin* and increase of the red corpuscles, it is just as difficult to establish as a *crasis*, especially when the blood from a dead subject is subjected to chemical analysis. Chemical determinations of recent blood are therefore indispensably requisite, as by this means alone can it be ascertained whether the increase of albumen in the blood be primary or secondary. The albuminous nature of an exudation—for instance in *morbus Brightii*—does not necessarily lead to the conclusion that it has proceeded from an albuminous *crasis* of

[1] Lehmann ('Phys. Chemistry,' English translation, vol. ii, p. 243), states it as an aphorism, that the quantity of water in the blood is always proportional to its quantity of fibrin, though it is impossible to refer the augmentation of the *fibrin* in inflammation in a direct manner to the diminution of the albumen, that is to say, to explain the augmentation of the fibrin by a too early metamorphosis of the albumen into that substance, as some have attempted to do. If this be the case, it is directly opposed to Henle's notion, that the increased amount of *fibrin* in the blood is due to the circumstance that where exudations have taken place—these effusions contain a less proportion of *fibrin* than is contained in the blood serum, which would thus be robbed by the effusion of proportionally less *fibrin* than water. But Lehmann's aphorism would appear to accord with the fact long recognized, that the amount of *fibrin* in the blood is augmented in many affections, which may be regarded as diseases of debility, or dependent upon a diminution of vitality in the blood; at any rate the proneness to the deposition of fibrin and its rapid organization in such affections has been long remarked, especially by Mr. Dalrymple ('Med.-Chir. Trans.,' 2d ser., vol. v, 1835; vol. ix, 1844).

the blood, unless, by chemical means, the latter has been previously shown to exist.

We must here remark how necessary for the proper understanding of the increase of fibrin or albumen in the blood, is a physiological knowledge of the development and retrogression of the blood-corpuscles—a knowledge which it is much to be regretted has not as yet been sufficiently cultivated.

If, for instance, it can be proved that the red corpuscles are developed from the fluid albumen, and serve as an intermediate agent in the change of the albumen into *fibrin*, a rational theory with respect to the increase and diminution of these substances might be established. The former, in that case, might be regarded as an excess of development; and the latter as indicating a defect in that respect, induced by the abnormal phases of development of the red corpuscles.

3. *Increase of the aqueous contents* of the blood (*hydræmia*), as an idiopathic lesion, cannot be disputed; it frequently appears as a secondary condition, and is to be regarded as indicative of impeded sanguification, such as arises in certain diseases of the lungs, heart, liver, kidneys, and after great losses of blood.

4. *An increase in the quantity of white corpuscles* (*leukæmia*), according to Virchow, occurs as in a defective development of the elements of the blood under various conditions, particularly after inflammations, venesections, in pregnant women, simultaneously with an increase of *fibrin*, in typhus, cholera, *pyæmia*, and also in chronic enlargement of the spleen, and in general hypertrophy of the lymphatic glands. Under these circumstances the increase of the white corpuscles is very evident in fibrinous coagula taken from the large vessels, and in the chambers of the heart.[1]

5. *An increased amount of fat* in the blood (*pionæmia*) renders the serum milky, and may also be recognized microscopically by the floating fat-globules. It occurs in old people

[1] The main difficulty, at present to be overcome, with regard to the affection described under different names by Virchow, and afterwards by Dr. Bennett, consists in the determination of the true nature of the "white corpuscles" observed in such unusual number in the blood. Morphologically they resemble the white blood-corpuscles—but they equally resemble pus-globules, and the endoplasts of epithethial and mucus-cells or corpuscles; but it has by no means been shown, as yet, in what respect these various elements agree with or differ from each other in their essential nature.

and in drunkards. In old horses, it sometimes happens also that such a quantity of plates of cholesterin exists in the blood in the heart as to cover the entire field of view. A certain degree of *pionæmia* probably also occurs after chylification. In hybernating animals a considerable amount of fat in the blood belongs to the physiological condition.

6. A diminished quantity of red corpuscles is stated to occur in *chlorosis*. A less deep red coloration of them may also be caused by a more scanty development of the colouring matter, or by a more watery medium, by which the latter is extracted.

7. The distinct *presence of urea* in the blood (*uræmia*) has been demonstrated by Christison and several other chemists, especially in Bright's disease, whilst in the normal condition of the blood, it would appear to occur only occasionally. In the blood of cholera patients, Reiny and Marchand found *urea*, though only when *ischuria* existed; Garrod also believes that he has found it in the blood of persons affected with gout. In serous exudations the presence of *urea* has been often demonstrated; but Lehmann has been able to detect it only where these coexisted with some lesion of the kidneys.[1] *Urea*, moreover, appears to him to exist in all the serous fluids, in Bright's disease. Schlossberger found it on one occasion even in the watery effusion in the cerebral ventricles.[2] In cases of *uræmia*, urea has also been found in matters ejected by vomiting, and in the saliva. The notion that the urea met with in cases of *uræmia* has been absorbed from the kidneys or urinary bladder, has been controverted by the presence of that principle in the blood of animals from which the kidneys have been removed. By simple ligature of the nerves of the kidneys in a Dog, Marchand produced all the phenomena of *uræmia*, and was able to prove, with the greatest certainty, the presence of *urea*, not only in the blood, but also in the matters vomited.

8. *Increase of the colouring matter of the bile* in the blood,

[[1] According to Bostock, whose statement it appears is confirmed by Dr. Garrod, *urea* has been found in the fluid of *hydrocephalus*, but whether coincident with any affection of the kidneys does not appear. ('Pathol. Anat.,' by Drs. Jones and Sieveking, p. 236).—Ed.]

[2] [In cases of advanced albuminuria (Bright's disease), *urea* has been detected repeatedly in the serous effusions so often, in such cases, found in all the visceral cavities; and in the aqueous humour of the eye.—Ed.]

which gives the exudations a light or deeper yellow colour. The bile-pigment is wanting in the blood, or its presence cannot be proved in inflammations, whilst cholic acid or its cognate acids are found in it; but the reverse is more frequently the case, bile-pigment being found in the blood, and no cholic acid (Lehmann).

9. *Increase of sugar* in the blood, occurs in *diabetes mellitus.* Although in this disease a peculiar change in the constitution of the blood might have been expected (Lehmann), such a thing has by no means been observed; for besides the increased amount of sugar it presents almost exactly the same composition as normal blood, except that it contains rather more water, and, in particular, less fibrin, whilst the blood-cells and solid constituents of the *serum* are but slightly diminished (Gorup-Besanez). The serum of diabetic blood is occasionally milky (Thomson).

From this brief sketch of the doctrine of *crasis,* it is obvious, that idiopathic or primary blood-crases as such, have not yet been demonstrated, and their causal relation to the different kinds of exudations must still remain doubtful: whilst, on the other hand, it cannot be denied that the blood-crases which in many cases are manifestly secondary to preceding local affections, influence subsequent exudations according to their own peculiar nature.

To obtain an idea of the *effects* induced by *exudations* in the living organism, we must pay close attention to the *situation in which they are deposited,* and carefully trace their *extent,* for upon these two points principally, depend the symptoms produced by them. This is easy enough when the exudation is deposited on the surface of membranes; but numerous difficulties often intervene, when we wish to subject a fluid exudation in parenchymatous organs, which has not become at all organized, to a more strict examination. The latter object is more readily attained when characteristic new formations have arisen from the exudation, which will serve as guides in the inquiry. If, for instance, *pus* or granular corpuscles are present, they will afford indications of the nature of the previous exudative process; coagulated exudations even, or such as have undergone fatty degeneration, may be ascertained by careful observation and constant comparison with other contiguous tissues.

It is easily understood that every exudation, being a *plus* of transuded nutritive material, must produce *a tumefaction* of the organ infiltrated with it; but it may happen that at the time we proceed to the dissection the more fluid constituents of the exudation have become absorbed, and the swelling no longer exist; a subsidence, also, of the swollen organ necessarily ensues in consequence of the stagnation which takes place after death, and of the gradual evaporation of the fluids. The *cornea* or external integument will serve as striking instances of this.

When the exudation has reached a certain volume, it will mechanically impede the circulation, in consequence of the *pressure* exerted by it upon the neighbouring parts of the organ, and this impediment will be the more marked in proportion to the rapidity of the effusion, and the extent to which it has taken place. Owing to this rapidly-produced and unequally-distributed pressure, the rupture of a smaller or larger vessel may readily ensue, and thus a *hemorrhage* be produced. At the periphery of an exudation, also, isolated extravasations of blood are frequently met with; but the hemorrhages, owing to the pressure and counter-pressure, soon reach their limit,—that is to say, the bleeding is stayed. These minute punctiform extravasations are usually termed *capillary apoplexies*, although the anatomical proof of such being their nature is wanting. It is just as likely that they may be derived from the minute venous or arterial trunks. The disturbance in the circulation around the exudation will now produce a new exudative process, and thus its advance may be explained in a mechanical way, until a term is put to it by external circumstances, and the special anatomical relations of the organ. The *nutritive conditions* of the latter must necessarily be altered by the increased transudation; more plasma will be afforded to the organ or parts of the organ involved than it can employ. This overplus, which cannot be applied to the formation of homologous elements, remains, as has been stated above, as an unorganizable material, or becomes the *matrix* of new heterologous elements, which, like parasites, by their independent increase, give the nutritive process another direction. The nutritive conditions of the organ will remain disturbed only until the unorganized exudation is absorbed,

and the organized is either removed from the organism, or undergoes one or other of the processes of involution already described.

A matter which has given rise to various theories is the disturbed sensibility—the *pain*, which is excited during and after the act of exudation. The physiological process attending sensation is unknown, and we cannot consequently give any satisfactory explanation why sudden or slowly-produced disturbances of the circulation in the sheaths of the nerves should produce a momentary or a more lasting painful sensation.

The *effects* of the exudation cannot, however, be limited to the region concerned, but must extend beyond it, and involve the entire organism to a more or less injurious extent, the more influential is the organ affected. A *local* and a *general effect*, therefore, must so far be distinguished.

The distinction between a *direct* and an *indirect* influence of the exudation appears to us sufficiently marked. The latter effect is one brought about by intermediate organs, chiefly vessels and nerves. To the veins and lymphatics especially has an important function been assigned, and it has been supposed that an exudation capable of being absorbed is conveyed from one place to another. Whence has arisen the doctrine of *metastasis*. Of this, however, the anatomical proof is wanting, and we have been obliged to substitute a secondary blood-crasis, produced by the unorganized or organized exudation. But this has been done without the due precision, and a name given to the *blood-crasis* to which, perhaps, it had no claim at all. Thus we often speak of *pyæmia*, but in this case the presence of pus in the *circulating* blood of the arteries and veins has never been demonstrated, and the existence of *pus* in some of the veins contiguous to a collection of matter, or in the lymphatics, is obviously insufficient to establish a *crasis* of the kind.

Lastly, we have to consider the *effect* produced by the *contagious nature* of many exudations. It is to be regretted that neither chemical nor histological researches have afforded any grounds from which we might come to a conclusion as to the specific nature of these exudations, whilst experiments in the inoculation of them have presented the most incontestable proof of contagiousness.

CHAPTER III.

PATHOLOGICAL CHANGES OF THE NORMAL CELLS.

It is well known that the tissue of the animal organism consists of minute separable parts of definite form and organization, distinctly visible only with the aid of a magnifying power of at least 300 diam., which will be termed *elementary organs*. The cells are elementary organs, consisting essentially of a "cell-membrane" and "contents." They constitute the true *parenchyma*, and require for their maintenance the *reception of fluid nutritive materials*, which are either conveyed to them immediately by the capillary vessels distributed in the *parenchyma*, or which reach them mediately through other permeable parts in a more or less fluid condition.

The quantity and quality of the nutritive material supplied by the circulating blood to the cells depends, in each individual, disregarding the possible variations of the constituents of the blood: 1. Upon the rapidity of the circulation, which is modified in very various ways by the disposition of the capillary ramification, whether the branches are given off under obtuse or acute angles—whether they run in a straight course or are convoluted—whether they form coils, soon divide into numerous twigs, &c. 2. Upon a possibly varying porosity of the walls of the different capillary vessels, of unequal diameters in different tissues.

But if the transuded *blastema* is modified by interruptions to the circulation, the nutrition of the cells is also changed. A more *rapid multiplication of the cells* may take place by division, or, in other words, the organ may become *hypertrophied;* or the cell is not supplied with plasma fitted for its nutrition, and undergoes involution; that is to say, the cell-contents in particular undergo such a change, that the cell gradually loses its vital properties and perishes. We would term this process in the *cell, involution* or *atrophy*, and shall advert to it in the Special Part of this work, as occurring in

many organs, convinced that the type of this retrograde metamorphosis remains everywhere the same.

Schwann has shown that the differences which exist between the independent cells are partly of a chemical nature, and in part referable to a difference in the growth of the cell-membrane, whence a morphological change of the cell may be produced. With respect to this he has remarked, that the cell-membrane in various kinds of cells is chemically different. The membrane of the blood-corpuscles is dissolved by acetic acid; that of the cells of cartilage not. Just as the cell-membrane of homologous cells at different ages presents chemical differences, so also do their contents, which undergo a transformation in the same cell. Young cells have hyaline contents; and a granular deposit is gradually formed, usually, in the first place, around the *nucleus*. Other cells, at a certain period, form fat; others pigment, in their contents. It would lead us too far from our purpose were we to further discuss the manifold and as yet too little studied metamorphoses of the cell-contents, though at the same time it appeared requisite that we should indicate the necessary connection between their normal and pathological metamorphosis.

We shall commence at once with the pathological metamorphosis of the *cell-contents,* which is brought about by deficiency of the nutritive material afforded to them. The most common form of metamorphosis or *degeneration* is the *fatty*. Smaller and larger granules make their appearance in the contents, which are strongly refractive, presenting a dark border and a brilliant central portion, and remaining unaltered when touched with acetic acid or soda. These fat-drops are sometimes so large as nearly to fill the entire cell. Care must be taken not at once to diagnosticate a fatty degeneration of the cell-contents from the presence of a few minute fat-drops in that part of an organ where the cells produce fat in the normal condition. The latter may be so abundant, that in a thin section nothing will be seen but a mass of fat-drops. The degeneration at the commencement is not uniform throughout the cell, the fat-drops accumulating usually in one part, and being grouped in such a way around the *nucleus,* that the latter is partially or entirely concealed by them.

The fatty degeneration of the cell-contents, by the reception

of colouring matter, may pass into the *pigmented*, although the latter may arise independently. The first modification of the pigmented degeneration, in all its stages, is easily followed with a little attention, since the colours from deep yellow gradually passing to brownish-black are presented in the cells whose contents have undergone fatty degeneration.

It may be assumed, with considerable probability, that the pigmented involution originates, for the most part, from the dissolved, colouring matter of the blood, which penetrates the cell-wall, and undergoes various changes of colour within the cell, although, perhaps, the pigment may also arise in a kind of carbonizing process of the protein substance contained in the cell. The colours are deep yellow, orange, brownish-yellow, brownish-red, and black, with innumerable shades of all these hues. The molecules of pigment may either be still separable, or they may be so united together, that nothing but an opaque mass can be distinguished. In general, the pigmented form of involution of the contents appears to be developed more slowly than the fatty; under particular circumstances, however, the development takes place more rapidly.

If the blood contain an undue amount of water, the cell becomes distended by imbibition, rupture readily ensues, and the diluted contents escape. Such a change of the cell-contents is termed *dropsical* or *aqueous*. Its formation must take place with comparative rapidity.

There are, doubtless, several other metamorphoses of the cell-contents, but which are observed with more difficulty. If, in consequence of a disturbance in the circulation, a larger quantity of albumen transude, the richer nutritive material will also influence the form of the cell-contents. In speaking of the adipose tissue, we shall become acquainted with metamorphoses of this kind, which are probably due to the *reception of albumen.*

It is no less probable, we think, that a *fluid colloid-substance* may penetrate the cell wall, and induce modifications in the contents.

By the abstraction of the watery portion, as may happen where the supply of blood is deficient or wholly wanting, the *quantum* of the cell-contents is *diminished,* the materials can no longer remain in a state of solution, and crystals form in the interior of the cell.

It has been long a well known fact that the lamellar deposits are formed on the inner surface of the cell-membrane, successively from without to within, and are to be regarded as a solid continuous substance precipitated from the cell-contents. Now, these *lamellar deposits* on the cell-membrane also occur in pathologically metamorphosed cells, as we shall show in the course of the work, in cartilage and fat-cells. This view appears to us much more likely than to suppose that these concentric layers, formed on the cell-membrane, represent a thickening of that part.

The cell-membrane varies in thickness in cells of different ages; in young cells it is obviously thinner and less resistant. It is, therefore, conceivable that the thin-walled cells are more easily ruptured by the imbibition of water than those with older and thicker membranes, which are capable of enduring a more powerful distension. In numerous cases a very rapid disappearance of the cell-membranes takes place, caused by the chemical properties of many exudations, and in consequence of which a solution of them is effected. By the abstraction of a considerable proportion of the fluid contents, the cell-membrane becomes wrinkled, as may sometimes be observed in the shrunken fat-cells in *lipoma.*

With respect to the question, as to whether the *nucleus* participates in the pathological metamorphoses of the cell-contents,—whether, for instance, it undergoes fatty degeneration, it must be confessed that we have never been able fully to satisfy ourselves that this is really the case. The difficulty attending the ascertainment of this point will be apparent to any one who considers that both the fatty and the pigmented degeneration frequently commences at the immediate neighbourhood of the *nucleus,* in consequence of which the latter is often concealed from observation, without its being justifiable to assert that it has become degenerated in the one way or the other. On the other hand, we have so frequently an opportunity of demonstrating the existence of the *nucleus* in cells thus metamorphosed, that well-founded doubt will arise whether it has become degenerated in those cases where it escapes our observation. The possibility, however, of its undergoing degeneration cannot from this be denied, *à priori;* and we think, therefore, that no decisive opinion should be expressed upon

the subject. The *nuclei* in cells of one and the same kind are of various size and figure; their contents also themselves vary. The *nuclei* of younger cells are larger, vesicular, often quite transparent, or enclosing a fine molecular substance; whilst those of the older cells diminish in size, the smooth surface being replaced by a sinuous one, and at the same time they often become elongated. Several granules are perceptible in the interior. But this general typical form may, it is true, undergo various modifications. The common chemical character of most *nuclei*, consisting in their not being rendered transparent by acetic acid, whilst that reagent renders the majority of cell-membranes hyaline, is very valuable in those cases where we desire to satisfy ourselves by chemical reagents of the nature of the *nucleus*. It not unfrequently happens, for instance, that, of the *parenchyma* of an organ, nothing remains but the *nuclei*, surrounded by a group of molecules, united by a connective substance. In the decomposition of an organ, the *nuclei* offer considerable resistance, and are even still to be met with when not a single perfect cell can be discerned.

What pathological changes the *nuclei* undergo in the involution of the cell cannot be stated.

A *coalescence* also may take place between several cells contiguous to each other; that is, the walls become invisible, and a larger or smaller cavity is formed, containing *nuclei* imbedded in a molecular substance. Even these may disappear; and nothing remain but a hyaline space, enclosing a few granules. This retrograde process appears to take place in consequence of the reception of a fluid matter, chiefly of an albuminous nature, or containing colloid. We shall say more concerning it in speaking of cartilage.

Schwann has shown that the *intercellular substance*, or the *cytoblastema* external to the cells, is subject to the same changes as those which occur in the cell-contents. Usually, its quantity diminishes in proportion to the growth of the cells. With respect to the physiological relation of the cytoblastema to the cells, it may be twofold. In the first place it must contain the nutritive matter for the latter; and secondly, it must, at any rate to some extent, retain what remains of this nutritive material after the cells have taken up what is requisite for their growth. In animals the cytoblastema

receives the new nutritive materials from the blood-vessels. This theory of Schwann's also finds its full application in the pathological metamorphoses of the *blastema* deposited in the normal condition among the cells. The most frequent change is *fatty degeneration*. Larger or smaller fat-globules accumulate in this interstitial substance, so that the cells appear to be bordered by a circle of fat-drops. The latter may also be aggregated into larger groups, when the space occupied by the intercellular substance is more considerable, as, for instance, in cartilage-tissue, which in consequence loses its normal transparency and consistence.

Pigmented metamorphosis takes place when colouring matter is deposited in the intercellular substance. In lower degrees this change is indicated by opaque, brownish-yellow, brown-red, or blackish specks of small size, in which the pigment-molecules may be still sometimes distinguished, and sometimes only dark-coloured diffuse spots are visible. The greater the extent and intensity of this colouring by pigment, the more completely must the intercellular substance disappear. We shall have an opportunity of referring to these observations more particularly in speaking of cartilage and bones.

If the transudation destined for the restitution of the intercellular substance contain chiefly watery elements, or, in other words, if a dropsical effusion be poured out, the intercellular substance undergoes a *dropsical* or *watery* degeneration, which proceeds, *pari passu*, with the degeneration of the cell-contents above described, and causes the cells to be more readily separable, or even wholly isolated.

In many tissues the intercellular substance undergoes a peculiar metamorphosis, which may be termed "cleavage." It consists in a breaking up of the apparently homogeneous substance, and appears to take place not so much in consequence of a deficiency of nutritive fluid (a kind of desiccation), but rather by the intervention of a nutritive material, which, owing to its peculiar chemical properties, causes a separation of the individual layers of the intercellular substance. We shall meet with this process in the most marked way in cartilage and bone. Lastly, a development of *gaseous fluids* may cause a disruption of the mutual cohesion between the cells.

Relying upon these observations, we may be allowed to

propound a *theory of involution*, which appears to us a scientific postulate for the necessary comprehension of the various phenomena.

If we desire to resolve the life of the organism, as it were, into its elements, we must endeavour to acquire a more intimate acquaintance with the vital properties of its elementary organs—the cells. We must endeavour to ascertain how the first appearance of the cells in the homogeneous *blastema* is evidenced—how their multiplication by division proceeds—what metamorphoses they undergo—what are the conditions presented in the cells in their further existence—whether they remain stationary in their external habit or not—what stage of development they reach—whether motile phenomena occur in them,—or, in other words, we must strive to comprehend the cells as something living, in their nutrition, propagation, and movement. This vital and physiological survey must also be carried on in a pathologico-histological point of view, so that we must not be content to confine our regards merely to what is presented in the dead subject.

Just as the organism, as an individual whole, requires for its maintenance, nutrition, propagation, and motion, which are carried on only under certain external conditions,—just as when it reaches a certain point of development it remains stationary, and, as a whole, undergoes no further development of its vital properties, but begins gradually to retrograde, seeing that the sum of the vital phenomena is reduced to a smaller quantity, which, after a gradual diminution, falls to a minimum, and ultimately disappears,—which event we term the death of the organism,—so is it on the small scale with the elementary organs. The involution of the organism, however, does not proceed in a uniform and equal manner throughout; individual organs undergo involution earlier than, and in a different way to, others. Thus, if the ovary, in the female, ceases to perform its function—which is the development of the unimpregnated *ovum*—at an early period, the proper *parenchyma* of the mammary glands will exhibit a different mode of proceeding in its retrograde metamorphosis.

In these processes the affected organs necessarily receive less material applicable to their nutrition, or in their reception of it they must be impeded by corresponding external unfavorable

conditions. Now if the absorption of the fluid nutritive material, and the giving off of the non-assimilable parts, do not proceed according to the determinate mode appropriate to the cell, unorganizable elements will be left, and undergo the same metamorphoses which we have enumerated as forms of involution of the separate parts of the cells. The defective assimilation of the cells removes them, as it were, from the domain of vitality, and they remain like dead particles, incapable of again entering upon their proper formative processes, enclosed within the sphere of the living organism.

The possibility of the occurrence of a defective nutrition in the cell involves that of the opposite condition or of an excessive nutrition; or in other words the possible occurrence of *atrophy* in the cell in the one case, implies in another that of its *hypertrophy;* which latter condition is produced by a relatively excessive quantity of the nutritive material afforded to it. But this condition presupposes an exalted degree of assimilative power, without which the nutritive matter would remain an *indigesta moles.*

In this hypertrophy the new molecules may be conceived to be deposited in two ways: they are either arranged uniformly around the whole periphery of the cell, or the deposition takes place in one part or another of it, unequally. There would thus arise a *partial* and a *total* hypertrophy of the cell, which latter may produce numerous modifications of form.

The exalted vitality of the cell, however, is not limited simply to an exaltation of the assimilative power, but also extends to the augmentation of the propagative faculty, in consequence of which a larger number of cells is formed by the process of division, when an increased supply of nutritive material is afforded. The result of the hypertrophy of the cells is an increased volume of an organ.

This frequently happens, also,—that the nutritive material is not all applied to the purposes of assimilation, and consequently, some of it remains between the elementary structures as an inapplicable portion, and undergoes the same metamorphoses, as those which we have described as occurring in the involution of exudations. It has already been stated that hypertrophy of one part of an organ may co-exist with atrophy of another.

CHAPTER IV.

PATHOLOGICAL, NEW-FORMED CELLS.

However incomprehensible it may seem, *a priori*, that from a fundamental substance, the formative material or plasma, with whose more intimate chemical properties, it must be confessed, we are as yet unacquainted, parts apparently chemically dissimilar to it should be produced and, moreover, of great diversity of form, still we can scarcely doubt that, at any rate, a partial explanation of the phenomenon may hereafter be expected; modern chemistry having afforded such available results in the elementary analysis of organic bodies.

As everywhere else, so in this case, we are not in a condition to assign the cause of the specific formation of the *blastema*—its essential nature. We are consequently obliged to substitute a name for this unknown quantity, though it should be clearly understood that it is merely a name, unconnected with any distinct idea. We speak of a specific plastic force, knowing, however, that in that expression nothing more is meant than the keystone of our conceptions with respect to the special organic formations of the *plasma*.

It has been explained above, that the pathological plasma or exudation arises from an increased transudation of the *liquor sanguinis* under disturbed conditions of the circulation; and with respect to this, chemical research has as yet afforded the most unsatisfactory results. With regard to the concentration of the formative fluid, Schwann has established the law that a concentrated solution is required for the first formation of a cell, as well as for the growth of one already formed.

In ordinary crystallization also, the solution must be more than saturated for the crystallization to commence; when this has taken place, the fluid may serve, probably, for the growth of the crystals, though no longer for the commencement of crystallization.

The basis of the tissue of all pathological new formations,

is constituted by the cells. We have, therefore, in the first place, to trace their mode of formation, to explain their various forms, and the metamorphoses the latter undergo.

The *forms* assumed by the newly developed cells are very numerous, varying according to age, their different kinds, and a variety of malformations. Regarding the question in a genetic point of view, we shall commence with the form of development.

Two modes of cell development may be distinguished, a *free* development originating in the amorphous *plasma*, and one by *division*. Schwann has endeavoured to show, that in the formation of the elementary parts, the way in which the molecules are conjoined does not differ according to the physiological nature of these elementary parts, but that they are arranged everywhere according to the same laws, so that whether it be a muscular fibre, a nerve-tube, an *ovum*, or a blood-corpuscle of determinate form or of one subject to only trifling modifications, that is to be developed, a *nucleus* arises, a cell is formed around this body, and it is only in consequence of the changes undergone by one or by several of such cells, that the subsequent forms of the elementary parts are produced, or in a few words, that a common principle of development governs all the elements of the organism.

The matter, however, does not seem to be so simple as this, and it is still very questionable, whether this last assertion be universally applicable, or whether divers modes of formation may not exist. In order to show, how even in Botany, where the conditions to a great extent are patent, and, consequently, more readily embraced, this question is still very far from having received a satisfactory solution—we will adduce the following remarks. With respect to the way in which the *nucleus* is formed in the granular protoplasm. Hugo von Mohl states that opinions differ very widely. The first observer who recognized the import of the *nucleus* and its development, was Schleiden. According to him, rather large globules are first formed in the protoplasm (the future *nucleoli*), around which the other granules become aggregated, coalesce to a greater or less extent, and uniting form the *nucleus*. Whilst, according to Nägeli, a considerable mass does not at once unite to form the *nucleus*, but that body is said to make its appearance as a very minute corpuscle, seeing that the very commencement of

the formation of the *nucleus* may be distinguished, although at first it be little larger than the globules of the protoplasm. He also assumes that the *nucleolus* is first formed, around which a layer of protoplasm is afterwards deposited, which itself is again invested by a gelatinous membrane, not coloured by iodine. W. Hofmeister expresses himself decidedly in opposition to both these statements. From his researches it would appear that the formation of the *nucleus* is not preceded by the development of the *nucleolus*, and that free corpuscles are never met with floating about in the cell-juice, but the *nucleus* arises under the form of a spherical drop of mucous fluid, which subsequently becomes invested with a membrane. In many cases the *nucleus* does not at first present a trace of a *nucleolus*, and it is not till afterwards that one or several are formed in it, whilst in other cases, from the very beginning, one or several granules of a more solid substance swim about in the fluid of the *nucleus*, but which are not of necessity all developed directly into *nucleoli*, inasmuch as only one of them may increase in size, and become invested with a membrane, whilst the others are dissolved. Mohl appears to regard the latter view as the more correct, except as regards the existence of the membrane around the *nucleus* and *nucleolus*, of which he has been unable to satisfy himself; he looks upon Nägeli's view as decidedly erroneous. With respect to free cell-formation, Mohl furthermore expresses himself in the following terms: "Although it is the rule, to which in the normal development of the cells of all the higher plants there is no exception, that in the nitrogenous substances, which give rise to the formation of a free cell, cell-nuclei make their appearance, this is by no means a necessary condition, but it seems that every spherical mass formed entirely or partially of protein-compounds may assume the functions of a *cell-nucleus*, and become invested with a membrane composed of cellulose, and thus give rise to the formation of a cell."

From our own observations with respect to the elementary forms which first make their appearance in the pathological plasma, we feel compelled to adhere to Mohl's view. It is certain that even in our protoplasm there is a primary formation of *nuclei*; but under what conditions this takes place it is by no means easy to ascertain. It is too arbitrary an assumption

at once to explain the groups of molecules which occasionally are the first to appear in the plasma, as being *nucleoli*, seeing that these pretended corpuscles are often absent, and there are many elementary organs, whose *nuclei* present no *nucleoli*. Bruch and Virchow go so far, in fact, as to assert that in pathological cells the *nucleolus* never exists before the *nucleus*; that it is, on the contrary, more probably a secondary formation in the *nucleus*, which, according to Virchow, indicates a certain age of the latter, and according to Bruch a tendency to endogenous new formation in the *nuclei*. This assertion, in our opinion, is expressed too generally, seeing that in the independent multiplication of the large *nuclei* in medullary cancer we decidedly witness a division of the *nucleolus* preceding that of the *nucleus*.

A further question arises with respect to the vesicular nature of the *nucleus*, whether the frequently very obvious dark border at the periphery of the *nucleus* is to be regarded as a membrane investing it, or merely as representing a greater density in that portion of the substance. But the solution of this question has not yet been attained to.

The primitive formation of the *nucleus*, in the more manifest instances, appears to us to ensue upon the precipitation of a compact, frequently very transparent substance from the fluid *blastema*; which precipitate becomes aggregated into masses of tolerably uniform size, in which, the *nucleus* is not formed till afterwards. Very delicate, hyaline corpuscles, in particular, frequently occur (for instance, in the gelatinous masses of the *cervix uteri*), of pretty uniform dimensions, and which may be very readily overlooked. In consequence of their mutual pressure, they are compressed, and assume a polygonal figure; being arranged usually in series, or placed in groups together. In some a *nucleus* is apparent, without any granular appearance around it. These delicate elements cannot be equivalent to cells, and must be taken to represent coagulated corpuscles of uniform size. They are also frequently granular. Valentin termed these bodies, "exudation corpuscles," which name, as is at once obvious, has been unsuitably selected, inasmuch as they do not belong to the exudation as such. We should rather prefer the name of *primitive corpuscles*. It appears to us that the formation of the *nucleus*, and of the cell-wall

ensues as a secondary process in them. We are very far from regarding this as the normal mode of formation of the *nucleus*, though doubtful at the same time of the universal correctness of Schwann's view, that the more or less thick, sometimes homogeneous, sometimes granular layer deposited around the *nucleus*, is never formed until the *nucleus* has attained a certain stage of development. The peripheral portion of the layer surrounding the *nucleus*, appears to become consolidated, and gradually transformed into a membrane, which is not distinct until the substance enclosed by it has become diluted and liquefied. It is, in fact, indubitable, that in many pathological, newly formed, elementary structures, no development whatever of a cell-membrane takes place; the molecules consequently are merely held together by a connective substance. This is the case, for instance, in the pus- and granular corpuscles.

The existence of newly formed pathological elements of this kind (*e. g.* Lebert's granular globules), which, though possessing a cell membrane and molecular contents, present no vestige of a *nucleus*, affords room for a double mode of interpretation. They have either not reached to the formation of a *nucleus*, or if such have once existed, it has been removed by solution.

The second mode of development of the cell is that by *division*, a process which has also been termed *multiplication*. It consists in the introduction of a morphological metamorphosis of such a kind that *septa* are developed, by which the space occupied by the contents of the cell is divided into two or several distinct cavities. This process, as in plants, is preceded by the formation of as many *cell-nuclei* as there are sub-divisions of the *parent cell;* the cells contained in the latter have been termed *daughter-* or (*secondary*) *cells*. Cases, however, are met with, in which a separation of the cell-contents by *septa*, takes place into two or three divisions, but in which separation the *nucleus* takes no part; for instance, in those newly formed elements, which are met with on the inner surface of many cysts. In other cases, again, it very frequently happens (in the cells of medullary cancer) that 2-8 *nuclei* and more collect in one cell, and often, in fact, more to one side of it, without there being the slightest indication of a division of the cell-contents. In this case, therefore, there can be no

question of secondary cells. The latter, in general occur but very rarely.

Division may also be effected in another way; for instance, by a gradual *constriction* taking place from the periphery towards the centre, by which the cell is parted into two or more divisions. A fine groove is formed at the periphery of the cell which penetrates more and more deeply, until the portions which are ultimately united only by a slender bridge are completely separated.

The division of the *nucleus* takes place either before the formation of a cell-membrane or after it. Multiplication proceeds in the following manner: the large *nucleolus* begins to elongate, presents two lateral grooves, and assumes an hour-glass shape. The two portions are separated by constriction, and two *nucleoli* make their appearance, which are at first closely approximated, and gradually more and more distant. With the divergence of the *nucleoli*, the *nucleus* also increases in length, exhibiting at the same time shallow lateral grooves which penetrate more and more deeply, until from a single *nucleus* two are produced, each furnished with the preformed *nucleolus*. The grooves proceeding on the periphery of the *nucleus*, are continued usually in two, often in three places, or, it may be, in four. The figure of the *nucleus* is thus rendered hour-glass shaped, or of a trefoil form. After a cell-membrane has been developed, the same process goes on within it; but it cannot, under these circumstances, be traced with the same precision.

Upon reviewing these primary modes of origin of the pathological, newly formed cells, and comparing them with those which arise in the normal *plasma*, we shall arrive at the conclusion that the mode of formation of the cell in the pathological *plasma*, is identical with that in the normal; a conclusion expressed years ago by J. Vogel, Günsberg, and several others.

We shall now proceed to trace the further development of the newly formed cells, and to describe the various forms which they assume, remarking also upon the interruptions to which they are subject in their development, and pointing out the modes of involution which they undergo. The fundamental form of the young cell is that of a *sphere*, or of an *ellipsoid*. They are seen very abundantly in those elementary

organs, which undergo no further development, as, for instance in the pus-corpuscles, which are sometimes furnished with a cell-membrane, in the "pyoid-globules," as they are termed, &c. These bodies, consequently, may be said to retain the fundamental form of the young cell.

By a gradual flattening on two opposite sides, the spherical form passes into the *discoid*, whose principal character resides in the diminution of the altitudinal diameter. Numerous varieties of this form exist, of which the principal are, the round, oval, and polyhedral. If the flattening take place, on two or several not corresponding places, we have the irregularly polygonal, elongated, flat form. The cause of the flattening may depend upon a dilution of the cell-contents, as Schwann has before remarked. If, as he expresses it, the contents of a spherical cell are altered in such a way that a fluid is produced in them of less density than the surrounding fluid, the cell loses some of its contents by *exosmosis*, must consequently collapse, and may thus be flattened into a tabular form, much like the blood-corpuscles, in whose case, however, the acetabular depression has still to be accounted for.

From the sphere or the ellipsoid is developed the *caudate form*, by a filamentary appendage being formed on one side of the round or oval cell, besides which, the latter appears to be attenuated at the point of insertion of the filamentary prolongation. The filament diminishes in thickness from that point to its acuminate extremity. Two modes of proceeding may be conceived as productive of this form. The cell is either elongated as a whole, by the apposition of new molecules, especially towards one side, or the cell-membrane is ruptured at a minute point, and a portion of the semifluid contents escape, and are immediately consolidated into a filament. The latter process, it must be confessed, has only once been observed in the young spherical cells of the cellular tissue in the Tadpole, in which, after rupture of the cell-membrane a portion of the contents was protruded in the form of a conical appendage, which in the course of a few seconds, was extended into a slender acuminate filament at least six times as long as the cell.

The *conical* form may be regarded as marking a transition

to the caudate, in which a less diminution of the transverse diameter of the cell takes place, in consequence of attenuation.

If two processes are formed at opposite points of the cell, so that the latter, in fact, appears to be drawn out in two directions, the *fusiform* figure is produced, modifications of which arise from the more oval or more elongated shape of the central or main portion. Not unfrequently a bifurcate splitting of one or other of the filamentary appendages is observed.

If, again, three or several processes project from the periphery of the cell, the *stellate* form, as it is termed, is produced, which affords numerous varieties, dependent upon the dimensions and figure of the body, and the thickness, length, and points of insertion, of the processes. The cells furnished with processes, like the ganglion-cells, may be distinguished into unipolar, bipolar, and multipolar, according as they are furnished with one, two, or several processes.

The *size* of the newly formed cells is subject to much diversity; whilst, on the one hand, it may not attain to the dimensions of the normal cell, on the other, it may far exceed them. In one and the same cancerous tumour, elements of the most widely different size are not unfrequently met with. The inordinate size is caused by an excessive nutritive and progagative faculty in the cell, which, moreover, may be limited to only some of the groups of cells.

The pathological newly formed elementary bodies often appear malformed, sometimes in consequence of an unequally distributed superfluity of development, sometimes owing to the development being interrupted; in which latter case the condition is attended with all the phenomena which we have described as belonging to the involution of the normal cell.

The malformations consist in the unsymmetrical development of the parts of the cell. The *nucleolus* may attain the comparatively enormous size of a pus-corpuscle, and the *nuclei* may be considerably distended, whence a coalescence of several *nuclei* appears to take place; or, on the contrary, they may become smaller, and undergo solution; the cell-membrane may be unusually thickened or attenuated. In consequence of these changes, the outline of the cell is altered in many ways, presenting irregular, boss-like enlargements, wrinkles, &c.

The *involution* of the newly formed cells may take place in every stage of their development, whence it is obvious that, a mass of elementary organs of this kind may cease to be any further developed,—stopping short at the formation of the *nucleus* or cell-membrane,—the cell contents, in consequence of the depressed vitality, degenerating; or, in other words, that the newly formed elementary organ will perish. The most frequent form of involution is the fatty degeneration of the cell-contents, occasionally passing into the pigmented. The newly formed cells may, besides this, become softened, shrunken, and cretified, or the subject of dropsical degeneration.

In taking a general survey of the shapes of the pathological, newly formed cells, we shall be unable to discover, even in those which are fully developed, any fundamental type peculiar only to new-formed cells; for the malformations which occasionally occur, whether they are referable to an excessive size of the *nucleus*, or of the *nucleolus*, or to the irregularity and more considerable dimensions of the external outline, may also be wanting, without the newly formed cell losing any of its character.

We sometimes hear of cancer-cells, and should, therefore, be justified in demanding such information respecting them as will place us in a condition to distinguish a cancer-cell from any other. But the supposed characters are referable to malformations, which, it is true, are not very rare among this class of cells, but they are just as often wanting, although the cancer-cell, nevertheless, would not on that account cease to be a cancer-cell. This proposition may be regarded as established, *that pathological, newly formed cells have no special characters peculiar to them.* It would certainly be very convenient if we could at any time at once recognize a cancerous, tubercular, or pus-corpuscle (an appellation likewise conducive to misunderstanding, as we shall afterwards see in the Special Part) as such, in the same way, for instance, as we can distinguish the itch-mite from the *acarus folliculorum*; but, alas! it is not so ordered for our convenience.

In continuing the general consideration of the subject, we come to the *connexion* of the new-formed cells. This may be so lax, that a very moderate pressure on the surface of a section of the new-formed tissue affords a mass of cells

which may be very readily isolated in water. In other instances, again, the connection may be so intimate, that pressure on the cut surface will not afford, as in the former case, a juice rendered turbid by the admixture of cells, but a transparent, limpid fluid containing scarcely any morphological elements. The reason of this difference, independently of a certain degree of laxity of tissue due to maceration &c., must depend upon the *chemical diversity of the intercellular fluid*, by which the elements are united sometimes more closely, sometimes more loosely.

The cohesion of the new-formed cells also depends upon the mode in which they are *mutually conjoined*, and the latter again upon their form. Flattened, new-formed epithelial cells, for instance, from the inner surface of a cyst, exist only in a single layer, and are easily raised from the surface in entire plates by means of a scalpel; but they are themselves tolerably firmly united to each other by a viscid, intercellular fluid soluble in water. Laminated flat cells are conjoined, loosely wedged together by their oblique lateral surfaces, and may readily be obtained in lamellar groups. Acuminated, elongated cells often occur closely wedged together. New-formed connective-tissue cells, as, for instance, in a fibroid growth, can be brought into view only after careful separation under water.

The disposition of the new elementary structures also depends upon the situation in which they occur; in a large space, and on a free surface, it will not be the same as in a more confined locality.

The *secondary arrangement* of the elementary organs, or the relative disposition of the groups formed by them, to each other, is by no means accidental, but takes place according to a determinate type, connected with the character of the new-formed tissue. The type necessarily alters, according as connective tissue, organic muscular fibre, bone or dentine, constitute the new formation.

The most extensively distributed type is the *areolar*, of which, on account of the frequency of its occurrence, as well, also, as on account of its relations to other formations, we will treat more thoroughly.

The areolar (better than alveolar, because *area* signifies a free space, *alveolus* a depression or space entirely closed on one

side) tissue has, in our opinion been hitherto too little regarded in its various forms by German histologists; English writers having given it the proper appellation. Todd and Bowman were the first to give a good figure and a corresponding description of this tissue. Among the Germans, it is well known that Henle had previously proposed the adopted name of "connective tissue" instead of "cellular tissue," because the idea of a cell involves that of a closed space, but the spaces of the "cellular tissue" are not closed; if the latter term, therefore, be employed, it is requisite that the idea of the cell should be abstracted from it, and, instead, that of spaces communicating by connecting passages with others, alone comprehended under it.

The *areolæ* are formed by the fibrous fasciculi taking an arched course, and, consequently, decussating with others. The *fasciculi*, moreover, subdivide into secondary and tertiary branches, whence is produced a fine network of delicate fibrous bundles. This system of subdividing *fasciculi* is bounded by thicker bundles, constituting, as it were, the fundamental frame-work, or *stroma*. Nor should the fan-shaped expansion of a cylindrical bundle be overlooked, because it is precisely by this that the walls of the *areolæ* are chiefly bounded. The latter, consequently, represent incompletely closed spaces bordered by the fan-shaped expansions and bifurcations of the fibrous *fasciculi*.

The *areolar passages* are constituted of much-branched, sometimes tubular, sometimes fissure-like spaces, connecting the *areolæ*. It is through them that fluids may be forced from one *areola* to another.

The size and form both of the *areolæ*, as of the areolar passages, are very various. The chief differences in figure are shown in the rounded and fissure-like *areolæ*, and also in the simple and compound, which latter are subdivided into several secondary sinuses by projecting ridges, as may always be observed in the larger *areolæ*. When a fine section of an areolar tissue is made, the *areolæ* must necessarily be cut across in all directions; consequently, a tolerably extensive section is required to enable us to judge of their form.

In these spaces, the new-formed elementary organs are deposited, filling them more or less completely. It is probable

that the older formations of this kind are placed more towards the wall of the *areola*, and the more recent in the central part of it; but since, as we shall afterwards see, the grouped cell-formation proceeds in a serpentine line, the position just remarked has only an approximate probability. This much, perhaps, is certain, that the fusiform cells are usually met with on the wall of the *areola*.

It is self-apparent, that all areolar tissue in which new-formed elements are deposited, should not be regarded as newly developed, inasmuch as exudations may be poured out in the normal tissue, as, for instance, in *œdema* of the skin. But, on the other hand, a new formation of areolar tissue must be assumed to exist when it is present in large quantity, or when it occurs in an organ which, in the normal condition, contains no areolar tissue of the kind.

A type, closely connected with the foregoing, is the *papillary*, *villous*, or *clavate*, which becomes the *dendritic vegetation* of Rokitansky, when the hollow clavate processes, as they are termed by him, are developed, by their throwing out of protrusions and processes into *sacculi* of a secondary and tertiary order. The shape of the *papillæ, villi*, club-shaped processes, or vegetations, is sometimes tapering, sometimes conical, cylindrical, or tuberculous, and verrucose, with every variety of intermediate form. In size, they vary from a diameter of 0·039″ and more, to one requiring a magnifying power of 50 to 100 diameters, for its distinct definition. The long diameter may considerably exceed the above, but in the case of those of the verrucose shape, it may be less than the transverse. These structures are affixed upon the parent surface sometimes by a slender peduncle, sometimes by a broader basis, placed in groups or isolated, and forming umbellate figures or botryoidal elevations. The arrangement of the elements composing them is as follows: On the surface, a *membrana propria* is occasionally demonstrable, or a simple layer of epithelial-like cells; in the interior, sometimes, a hyaline fluid, a more or less fatty or pigmented substance, or solitary cells of various characters, together with blood-vessels, or blood simply enclosed in a space.

These new formations occur either upon free surfaces, serous membranes,—as the arachnoid, *pleura, peritoneum*,—on synovial membranes, or within the areolar tissue. Rokitansky has

pointed out their frequent occurrence in the *stroma* of *cancer*, and in cysts.

Both these types constitute the basis of the secondary arrangements of the pathological new-formed elementary organs. We shall show, that the *areolar* and *papillary* types of *tissues, extend through the entire group of compound vegetations* (neophytes).

CHAPTER V.

FORMATION OF FIBRES.

A portion of the *fibrin* of the blood, prepared for microscopical examination, procured from the dead subject, and freed from albumen and other constituents of the serum, exhibits the appearance of a fine, intricately interlaced network of filaments. The filaments are short, and of pretty nearly uniform thickness, presenting angular curves, and are never arranged in parallel bundles. Larger and smaller interstices are left in this filamentary network, which are occupied sometimes by blood-corpuscles, sometimes by a transparent fluid. As regards the process followed in this formation, it may be supposed that when the fluid fibrin is removed from the circulation, its state of aggregation becomes altered, more or less rapidly, according to circumstances; passing into the solid state from the surface, inwards, in which proceeding the molecules rapidly coalesce, and form short, interlaced filaments, without their having previously entered into any stage of development.

This coagulation cannot go on simultaneously in all the layers of the fluid fibrin, since it is not possible that the external circumstances should act with equal intensity throughout; at most, the difference of time, when the influence is very intense, may be inappreciably minute. It may also, perhaps, be assumed, that in the case of thin layers, a portion of the *fibrin* may remain fluid even after a certain lapse of time, whilst in another portion it has already become solidified, since the process must ultimately remain the same on the large as on the small scale. Now this fluid *fibrin* may be lodged in hollow spaces formed by the interlaced filaments, whence it is at once obvious that the spaces must be larger in proportion as the quantity of fluid fibrin is greater. It must also be allowed that the fluid *fibrin* may ooze through the porous network and, having assumed a viscous consistence, be retained in the

sinuses formed in the completely coagulated fibrin. When this mode of grouping of the filaments of *fibrin* is compared with the areolar tissue, a striking similarity will be apparent.

If we take, for example, blood in the fresh condition, pus, or the sputa from diseased lungs, and treat these substances with acetic acid, we shall remark an immediate turbidity to be produced, depending principally upon fine straight filaments, which in many places form a delicate interlacement, and which were not perceptible before the addition of the acetic acid. This form of coagulation differs from that above described, in this respect, that the filaments are longer, straight, rarely constitute a fine network, and are occasionally arranged several together and parallel to each other, though they never occur in delicate undulating bundles. These fibres differ from those of *fibrin* and of connective tissue, in the circumstance that they remain unaltered by acetic acid; they belong to the principle termed *mucin*.

Thus we find two elements, *fibrin* and *mucin*, which are directly produced by a change in the state of aggregation from the fluid to the solid condition, without their having previously entered any other stage of formation. They are met with in the most various morbid products.

Quite distinct, in an anatomical, chemical, and genetic point of view, are the fibres which belong to the *cellular* or *connective tissue*, and which cannot be confounded with the filaments of coagulated fibrin. They are characterized mainly by the delicate wavy course of the bundles formed by the united fibrils, and, when treated with acetic acid, by their exhibiting at certain intervals, numerous, oblong *nuclei*, after the bundles have been rendered so pale as to be almost indistinguishable. The origin of the connective tissue fibres is to be sought in gelatinous new-formations of cellular tissue, and it may be satisfactorily shown that the mode of origin from the fibre-cell is precisely the same as in the normal condition. We venture, therefore, to quote Schwann's description of the process of development of the cellular tissue.

"In the structureless, gelatinous, cytoblastema of the cellular tissue minute spherical cells are first formed, probably around a pre-existing *nucleus*. The cells containing a characteristic (?) *nucleus*, become pointed in two opposite directions,

and these points are drawn out into filaments, which occasionally give off branches, and ultimately break up into bundles of excessively fine fibres, which at first cannot be distinctly recognized when isolated. The further development now consists in a continuation towards the body of the cell of this breaking up of the main filaments into a bundle of finer fibres, so that subsequently a fibrous fasciculus proceeds immediately from the body of the cell, in which itself, at a later period, the same process of subdivision commences. Ultimately, the body of the cell is entirely broken up into fibres, and the *nucleus* rests merely on a fibrous fasciculus. At the same time the fibres are developed in such a way as to become separately, distinctly discernible and smooth, assuming an undulating course, and, in short, putting on the aspect of the common fibres of cellular tissue. Since the fibrillation proceeds from both sides towards the cell-nucleus, the fibres remain connected for the longest time close to that body, until at last this portion also becomes fibrous. The *nucleus* then remains for some time longer, lying upon the fibrous fasciculus, and is ultimately absorbed, so that in place of the original single cell, we have a bundle of fibres." From analogy, the same author considers it probable that the fibre-cells are hollow. Some support for this supposition may be inferred, in a pathological point of view, from the frequency with which fibre-cells, whose contents have undergone fatty degeneration, may be noticed. The connective tissue fibres, the main foundation of all tissues, play a very important part in all compound new formations.

The development of the elastic fibres has not been traced so far as to allow it to be stated with certainty, whether even in the normal state, they always originate in a fibre-cell. It is quite certain that fibres of this sort occur in a pathological new formation often in very great numbers, and of considerable thickness, the contiguous fibres also being interwoven into a close and fine lattice work, which presents the same morphological conditions as coagulated *fibrin*. The thicker, elastic fibres of course cannot be confounded with anything else, exhibiting on one side a strongly marked shadow, on account of their cylindrical figure, together with the well-known serpentine, frequently spirally contorted, tendril-like course; but the very delicate fibres when, not in connexion with cells or with

thicker elastic fibres, may, when very closely packed, give rise to mistakes. The unchangeableness of the elastic tissue in acetic acid and dilute solutions of carbonated alkalies must also not be lost sight of.

CHAPTER VI.

FORMATION OF THE AREOLAR TISSUE, AND OF THE PAPILLARY NEW-FORMATION.

The areolar cellular tissue is constituted, as has been said above, of inarching fibrous bundles, which by their ramification and decussation inclose spaces communicating with each other. In the latter exist the cells of the cellular tissue, rounded elementary organs, furnished with one or several processes. The fibrous framework and the elementary parts lodged in it are, consequently, the two things whose developmental relation we have to pursue. Let us reflect upon the possible eventualities of the formation, and endeavour to reconcile them with unprejudiced experiments.

First, as to the question—is the fibrous framework produced before, simultaneously with, or after the formation of the cells?

With respect to the mode of origin, let us inquire,—may it be assumed with certainty, that the fibres of the young pathologically new-formed tissue, also, always originate from fibre-cells; or do they arise, in some degree, by the intervention of coagulated *fibrin* or *mucin?* If we compare our observations with respect to the origination of the embryonic cellular tissue with the *formative process* (with respect to the former question) in the gelatinous new-formed cellular tissue, and in gelatiniform cancer, we shall find, that *the progress, or the series of successively developed elementary organs, in pathological cases, remains essentially the same as in the normal condition. The modifications which are found to occur, present no essential differences.*

The first morphological elements that make their appearance in the hyaline, pathological *blastema* are solitary, spherical, and granular cells,—sometimes with, sometimes without, any demonstrable *nucleus;* and isolated fibre-cells,—usually furnished with two, diametrically opposite processes, containing one, two, or more *nuclei*, and occasionally without any, and which are

capable of spontaneous division, so that from a single fibre-cell two are produced, a circumstance of considerable importance as regards our subject, and which has not, as yet, so far as we know, been noticed. A third process is often perceptible on the body of the fibre-cell, which runs either in the same or in a different direction to the other two processes. In addition to this, a third fibre-cell will present a fourth process given off from its body (*e. g.*, in the young cellular tissue-formation on the concave surface of the *placenta*), whence a figure is produced representing two fibre-cells whose bodies have coalesced. In the body of a cell of this kind, furnished, as it were, with four pointed protrusions, there may be observed sometimes one, sometimes two *nuclei*. These undoubtedly represent quadripolar fibre-cells undergoing division.

Now, the elementary parts just described, may be seen before any trace of a fibrous bundle is perceptible. We can, consequently, answer the first question by stating, that the formation of the cells precedes that of the fibrous frame-work. Before going further, it is necessary to consider those modifications in which the spherical elementary organs (gelatiniform cancer) occur, not solitary, but at once in groups, in places in the *blastema*, where few or even no solitary fibre-cells whatever, and still fewer fibrous bundles are to be met with. This grouping of the elementary parts sometimes takes place in the form of a cross, sometimes in that of a serpentine line. Hence, it is probable that the cause of this grouped disposition resides in an augmented multiplication of the cells by division.

For an answer to the second question, it is necessary that we should recur to what has been said with respect to the formation of the fibres, and also, to some extent, discuss it more fully. From the supposition thrown out by Schwann, it has been thought that the fibre-cell is hollow; and we have conceived that this supposition might be strengthened by the fact of the frequent occurrence of fatty degeneration in the cell-contents. The statement first made by him, also, will be remembered, according to which, the fibrillation of the process of the fibre-cell proceeds from its point towards the body of the cell. The matter may be put thus: let that part of a glove which corresponds with the hand be regarded as the body of the cell, the fingers of the glove as a fibrous

bundle. Now, if the membrane at the point of the angle between two fingers continue to grow towards the hand, the glove will ultimately be subdivided into five fibres. In the case of the fibre-cells of the cellular tissue, however, the additional difficulty occurs, that the fibrillation proceeds, from two opposite sides, towards the cell-body; and, ultimately, each fibre on the one side must correspond with another on the opposite side. But this can be as little explained as can the union of the corresponding primitive fibres in the reproduction of nerves. This attempted exposition of Schwann's may be assisted by the assumption that the contents of the fibre-cell are fluid, and gradually pass from the fluid into the solid condition, from the point of the process towards the body of the cell, during which the precipitated molecules arrange themselves in longitudinal rows, become fibres, and meet in the transverse plane of the cell-body. In consequence of the spontaneous multiplication of the fibre-cells, which indubitably takes place, entire chains and series of such cells are formed, all of which, passing in the way just described, into connective tissue fibrils, are metamorphosed into a more or less considerable fasciculus. At the same time, it is conceivable, or even actually demonstrable, that the multiplication of the fibre-cells, like the modified circular and spiral grouping of the spherical elements (gelatiniform *cancer*) above noticed, may also take place in a spiral form, in consequence of which a fibrous fasciculus is produced, enclosing a hyaline fluid blastema, or which is hollow; in fact, Rokitansky has shown the existence of such hollow connective tissue bundles in the *stroma* of cancer. Nor should it be overlooked, that the fibre-cells are arranged, not simply in longitudinal rows, but that they also present lateral branches of similar series of cells, so that dendritic ramifications of chains of fibre-cells are produced.

Now, let us suppose that three fibre-cells, *a*, *b*, *c*, occur in the hyaline blastema in various positions, from them as many chains of fibre-cells, *a′*, *b′*, *c′*, will be produced, which must decussate at three points. And if we suppose similar chains of cells to be placed above and below *a′*, *b′*, *c′*, we shall manifestly have decussations in numerous directions, and some of the series of cells disposed parallel to each other. It is also instructive to observe, that the spherical cells of the areolar tissue, which

are, nevertheless, also multiplied by division and disposed in groups, must be encompassed by the chains of fibre-cells transformed into fibrous bundles.

A second possible mode of origin of a tissue, closely approaching the areolar, is exhibited when the blastema is highly coagulable, and the *fibrin* or *mucin* contained in it assumes the form which we have already more particularly discussed (*vide*, formation of fibres), viz., a fibrous framework with intercommunicating spaces, in which an organizable fluid is lodged, which afterwards gives origin to spherical fibre-cells. It appears to us probable, that this fibrinous or mucinous framework, containing elementary organs imbedded in it, occurs in many, rapidly developed forms of cancer.

The second question, therefore, may be thus answered: that, in the great majority of cases, the fibrous framework of the areolar tissue is developed from the fibre-cells by spontaneous multiplication; and that, in other cases, a chiefly fibrinous or mucinous framework affords the sole or an accessory fundamental *stroma*.

Now, with respect to the process of development of the papillary new formation, or of the hollow clavate growths, and of the dendritic vegetation of Rokitansky, we have only to apply what has been above adduced on the subject of the mode of formation of the areolar tissue, and shall find that the formative process in question is also readily explained in the same way.

In many pathological *blastemata*, the multiplication of the new-formed elementary organs by division is very extensive; whilst, as these elements are usually developed only in a determinate direction, the absence of many-sidedness of the organization is recompensed by an extension in the single direction. This is the case, for instance, in the fibre-cells, which, in many morbid structures, exhibit an enormous productive faculty, so that the lateral branches above noticed again give off lateral twigs; and in this way an arborescent system of fibre-cells is produced. Now, this formation projects internally, on the one side, into the more spacious *areolæ* and areolar passages; whilst, on the other, less obstacle is afforded to its comparatively greater development on the free surfaces of organs, the mucous and serous membranes. When the productive faculty of the fibre-cells ceases, it is conceivable that those

last produced, at the extremities of the whole chain of fibre-cells will incline towards each other, and that in this way would be produced an arched bundle of fibres, such as we have often an opportunity of noticing at the clavate extremities of the dendritic vegetations,—for instance, on serous membranes. In the *areolæ*, particularly of the stroma of cancer, the projecting fibrous bundles frequently acquire an epithelial investment.

Now, if we consider the development of the fibre-cells in a spiral, it is obvious, as stated above, that a hollow fibrous bundle is produced after the completion of the fibres, which, after the fibre-cells have ceased to multiply, is closed in the way above described, by the mutual approximation of the latter. The process of formation of Rokitansky's "hollow tubes," may be explained in this way.

The papillary new formation, and the dendritic vegetation arising from it, do not, however, always attain to the stage of fibre-formation, often remaining, *apparently*, in the primarystate of nuclear formation, or the contents of the growth may even at once break up into an opaque molecular substance. The *nuclei* occasionally appear simply as lighter-coloured, minute, symmetrically distributed spots at the apex of the papillary new-formation, imbedded in a fine molecular substance, or disposed along the whole length of the growth (*vide* Gelatiniform Cancer). We have termed the *nuclear* formation merely apparent, since it is possible that the *nuclei* may belong to very delicate cells. Rokitansky has traced the development of these *papillæ* or clavate processes, in the so-termed false membranes or serous membranes, and describes them as conical and clavate processes, opaque at the free extremity, and usually transparent and empty at the base, growing from determinate spots which look like nodular points of the mesh-work. It is obvious that the earliest rudiment of the *papilla* is essentially the same, as that which may be observed in the young *villi* of the *chorion* in the first months of pregnancy, when they consist merely of a molecular substance. The same author has, moreover, observed, the farther development of the clavate processes in gelatiniform cancer. In this case he describes, besides the older stroma, consisting of slender, hyaline *trabeculæ*, occasionally broken up into delicate, undulating, curled

fibrils and pervaded by oblong *nuclei*, a second, of younger growth, constituted of stronger opaque *trabeculæ*, occasionally perforated by very minute openings, the former of which were composed of nucleated cells, together with elementary granules. Thus, from the papillary processes a new system of cells pervading the fibrous *stroma* would be formed. To explain the mode of construction of the papillary new-formation, it might be supposed that below the surface of a free membrane, or in a hollow tube of the cancerous *stroma*, composed of connective tissue, a *blastema* was deposited in certain, circumscribed places, in consequence of which an exalted productivity would be established, and new molecules be deposited among the older, which new molecules gradually accumulating, would produce a saccular protrusion. To render the matter plain, let us take four atoms, *a*, *b*, *c*, *d*, corresponding to a spot of the subjacent organ, and it will be allowed that these atoms must be separated from each other, if new atoms a', b', c', d', come to be intercalated. Eight molecules, however, cannot be lodged in the same space, consequently if opposed by any obstacle towards the interior, they must be deposited towards the exterior. The projecting *blastema* now undergoes a sort of organization, the new elements continue to multiply in it, and form catenated rows with lateral branches; in short, the same process goes on as that which we have described in speaking of the fibre-cells. Upon comparison of the dendritic ramifications of these new formations with certain crystalline forms (sal ammoniac, for instance), there will be observed, in the latter case also, at certain intervals, points at which branches and twigs are given off; and, therefore, a perfectly analogous type of formation will be seen to exist between organic and inorganic substances.

CHAPTER VII.

FORMATION OF THE VESSELS.

In the case of pathological new-formed cells, we distinguished a development of them from pre-existing cells, that is to say, a multiplication, and a free development from an amorphous *blastema*, without any pre-existing cells; and in the same way, in the case of the formation of vessels, we meet with a simple multiplication from already existing vessels, and a primitive origination in exudations undergoing organization; and we shall satisfactorily find that the formative type in the physiological condition is essentially the same as in the pathological.

Schwann has observed the *multiplication of the capillaries*, both in the germinal membrane of the Hen's egg, and in the tail of the Tadpole, and found that these vessels are not regularly cylindrical, but of very various diameter. "Usually they are widest where branches are given off, sometimes even wider than the common capillaries. The branches as they proceed from these dilated portions very rapidly diminish in size, enlarging again as they approach another wider part. All degrees of this attenuation may be observed, from vessels in which it is scarcely perceptible, up to some in which the narrowest part is scarcely thicker than a fibre of cellular tissue. Besides this, branches are sometimes given off from these wider portions which likewise become rapidly attenuated to the fineness of cellular tissue-fibres, and afterwards cease, before reaching another dilated part — cæcal branches." Kölliker has confirmed Schwann's researches on this subject, and also shown that the young capillary vessels are connected with nucleated, many-branched fibre-cells. The contents of the latter, as well as of the young capillary vessels, according to Kölliker, appear to consist of fatty globules. These globules are affixed in groups on the inner surface of the irregular young vessel.

Opportunities are frequently afforded of noticing appearances

in a pathological point of view, entirely analogous to the physiological process, in the so-termed false membranes developed on the inner surface of serous membranes. We have only to add the general observation, that the continued development of the fibre-cells in a spiral, finds its application in the capillaries, and that in this way the occurrence of *sacculi* may be explained.

The free development of the capillaries in an exudation, or their primitive appearance, also undoubtedly takes place in the same way as that already described by Schwann, as being followed in their development in the germinal membrane of the incubated egg (at the end of 36 hours). That is to say, stellate cells are formed,—primary cells of capillary vessels,—placed at certain distances apart. "The elongations of various cells meet, the dissepiments are absorbed, and thus is produced a network of canals of very unequal dimensions, since the elongations of the primary cells are far slenderer than the bodies of the cells. But these elongations or connecting canals of the cell-bodies, continue to enlarge until they all attain to a uniform size, equal to that of the cell-bodies, which contract in the progress of growth; in this way a *plexus* of canals of uniform diameter is formed. The blood-plasma constitutes the contents both of the primary as well as of the coalesced or secondary capillary-cells, and the blood-corpuscles are young cells formed in the interior of the capillary vessels."

In pathological instances, a certain excess, and occasionally a deficiency in the formation of capillary-cells, cannot be denied to exist, in these cases, therefore, various forms are met with. In formations of this kind, we frequently find sacculated aneurismal dilatations, termed by Bruch sacciform vascular new-formations, referring them, as we think correctly, to the "germinal sacs" of J. Engel. We also conceive that the supposed enlargements of the capillaries in an inflamed part of the human *cerebrum*, containing blood- and lymph-corpuscles, observed by K. E. Hasse, and Kölliker, belong to the same category, and are to be regarded, not as dilatations of the capillaries previously existing in the tissue, but as new-formed vessels of the kind now in question.

The diameter of the pathological, new-formed capillaries, is in general more considerable, and increases or diminishes with

greater rapidity, than that of the vessels of normal tissue. The structure, also, in the vessels of larger calibre, to which, judging from the normal, a more complex kind of construction would seem to belong, is usually one of the simplest kind, consisting, in fact, merely of fibre-cells, disposed in the longitudinal direction of the vessel, and furnished with oblong *nuclei*; more rarely a transverse layer of fibre-cells is superadded; but more frequently a thinner or thicker layer of undulating connective-tissue fibrils.

It is obvious that the blood, which is newly formed in vessels, spontaneously developed in the exudation, cannot enter the circulation, until, by the multiplication of the new-formed capillaries, the communication between them, and the normally existing vessels is definitively established. The new-formed blood, properly speaking, can be continually urged backwards and forwards, only on the supposition that the fibre-cells of the vessel, and those immediately contiguous to it, are contractile.

The blood-vessels in new-formed tissues usually ramify in the same manner as those of connective tissue; the vessels may be noticed running in wavy, more or less abrupt curves, in many places forming vascular coils, and breaking up into occasionally very delicate, much interlaced capillaries; and not unfrequently we may observe parallel vessels, as is well known to be the case, in the connective tissue. The number of blood-vessels is very unequal in different new formations, and even in the same, in different parts of it, and depends much upon the basis or organ upon which the new formation is situated.

CHAPTER VIII.

FORMATION OF CYSTS.

Observers have latterly arrived at the conviction that the idea comprised in the term "cyst," must be restricted, in order to avoid the throwing together of things which have manifestly no mutual relations. For instance, at the present day, we no longer term a membrane of connective tissue, such as is formed in *cancer* and *sarcoma*, a cyst, but regard it as an hypertrophied capsule composed of connective tissue; nor should the cavities which arise in medullary *cancer*, in consequence of softening of the substance, be described as cysts. According to our notion, the *cyst* consists in an excessive augmentation of volume of the *areolæ* of the areolar tissue and of the papillary new formations composed of connective tissue; which augmentation is limited to smaller or larger portions of the tissue. *Cysts*, therefore, would stand in intimate relation to the last-named formations, from which, in fact, they would originate.

Favorable conditions, therefore, for the origination of cysts would be afforded in all those organs, which, in their normal anatomical condition, include partially or completely closed saccular spaces, and which besides that, in their pathological states, are especially prone to the production of new formations constituted of the areolar tissue, and of papillary excrescences (*e. g.*, thyroid gland, kidney, mammary gland, ovary, &c.) The formation of cysts, therefore, may take place in any organ, only it will occur the more rarely in proportion to the rareness with which new formations of areolar tissue are produced in the organ. We regard cysts, consequently, not as anything substantive or primary, but as of a secondary nature.

Before proceeding to the mode of formation of cysts, it is necessary to consider their intimate structure.

In the perfect cyst-wall there are *two layers* which demand attention:—1. The external tunic, composed of connective

tissue, and constituted of intricately interlaced, more or less lax, connective tissue-fibrils. Towards the part by which it is attached to the parent tissue, consequently towards its basal portion it is always more dense, a circumstance especially apparent in pedunculated cysts. This membrane also contains blood-vessels, often in a high degree of development, and forming a more or less complete capillary system. 2. On the inner surface of this tunic a single layer of flattened, more rarely conical cells is apparent, which is termed the epithelial layer of the cyst. It is not found to cover the whole internal surface of the cyst, being absent from those parts at which ridge-like processes of the external connective tissue layer project into the interior. Blood-vessels proceeding from the outer layer also run in these projecting ridges, and often give rise to hemorrhages into the cavity. Papillary, and also dendritic new formations may often be noticed upon these projections, which may attain such dimensions as more or less completely to occupy the cavity of the cyst; they lodge in their interior, vessels derived from the connective tissue tunic, and frequently present an epithelial layer on their exterior. These hypertrophied ridges of connective tissue and papillary new formations, may themselves again be metamorphosed into cysts, when we have a larger cyst enclosing several smaller ones.

The *contents* of the cyst are usually fluid, albuminous, or of a colloid nature. If its organizability is promoted by a greater development of the vascular system, and by an exalted formative *nisus* in the parent tissue, new organs even, may be produced upon, or in the layer composed of connective tissue, of the cyst-wall—which new productions, however, though contained in the cavity, did not originate on the inner surface of the cyst. It is in this way that may be explained the possibility of the occurrence, in the contents of cysts, of hairs, sebaceous and sudoriparous glands, teeth, portions of bone, or as has been above noticed, of papillary, dendritic new formations.

The *immature cell-wall* is not lined with the epithelial layer, and consequently represents merely a tunic composed of connective tissue, enclosing a more or less thin fluid, often in the coagulated state. This defect occurs sometimes in young immature cysts, scarcely visible to the naked eye, and which are to be sought for in the papillary new formations, some-

times in the walls of larger cysts, apparently in process of involution.

An important difference in the structure of cysts, consists in the circumstance that their cavity is sometimes completely closed, and sometimes communicates with the contiguous areolar spaces by fissure-like passages.

An apparently peculiar modification of the cyst-wall is observed when new cysts are developed in the immediately contiguous areolar tissue in which the cysts are situated; or their wall itself may be in part replaced by a formation of cysts, situated more in the outer wall of the connective tissue tunic. Into the interior of many of these adventitious cysts several smaller ones project, and others again into these, so that an entire system of cysts, one within another, is formed, lying upon the wall of the large cyst.

We have indicated the areolar tissue and the papillary new formation, as affording the foundation of cysts; with reference to which it appears necessary again to remark that the former tissue is constituted of thick bundles of connective tissue, enclosing a complete system of other fasciculi branched in a dendritic manner. The *areolæ* enclosed by the stronger external fasciculi, might be termed *areolæ* of the first order. From these fasciculi, branches are given off, which subdivide the *areola* of the first order, into several compartments, *areolæ* of the second order; these again are subdivided into *areolæ* of the third order by other branches, and so on. This mode of subdivision is found to obtain wherever connective tissue exists; in the so-termed parenchymatous organs it forms the fundamental framework. In pathological instances, we frequently observe an asymmetrical hypertrophy of the fasciculi, and in these cases it is that the formation of cysts so readily takes place.

Now if we suppose that, from a vessel whose branches run along the subdivisions of the *fasciculi* of connective tissue, an exudation, or perhaps, more properly speaking, a somewhat augmented transudation takes place, the possibility arises of the introduction of a new formation of fibre-cells, and of a multiplication of the blood-vessels, in consequence of which, an internal occlusion of the cavity of the *areola* is brought about. This being the case, should a further repetition of the transudation

occur, and the latter not be capable of organization it will accumulate in the *areola*, whilst the growth of the new formation advances outwardly from the cyst-wall. In this way may be developed epithelial cells, various forms of immature elements of cellular tissue, especially fibre-cells, and from these the papillary new formation with dendritic branching, and, when the formative impulse is greater, hairs, teeth, &c. Now should the same process go on in a whole system of *areolæ* contained one within another, a similar system of cysts will also be constituted, cysts of the *first*, *second*, and *third orders*, &c. The same process, on the other hand, of partial or complete occlusion, may be limited to an *areola* of the first order, whilst in those of the succeeding orders, from the pressure of the transuded fluid, the fibrous framework undergoes a partial or complete fusion; in consequence of which, a more or less sacculated cyst, furnished with projecting ridges of connective tissue, will be produced.

If the papillary new formation, in consequence of a dropsical degeneration of its contents, particularly in its clavate extremities, present a more or less circumscribed dilatation, the form of a pedunculated cyst is produced, which either depends free into one of the visceral cavities, or, when the cysts are more numerous, they may fill a distended *areola*. Concretions may be deposited in it; the peduncle may become so slender, as ultimately to be ruptured, and the cyst deprived of its stem, or the concretion, will be found detached in a visceral cavity, as is frequently the case in the cavity of the abdomen, and in the articulations.

We have now to consider the modification observed in the origination of a cyst, dependent upon the special anatomical structure of an organ, the mode, however, remaining essentially the same. If we regard, for instance, a group of *acini* of the mammary gland, it is well known that each group has a single excretory duct, and that it is enclosed in a tunic of connective tissue, which is subdivided into as many compartments as there are *acini*. Now, should an increased transudation take place in the connective-tissue tunic, in consequence of which a new formation of fibre-cells, blood-vessels, and papillary excrescences is there set up, the proper glandular *parenchyma* must of necessity be subjected to a pro-

cess of absorption, and a cavity is formed partly filled with variously shaped excrescences, and which is necessarily in connexion with the corresponding excretory duct of the group of *acini*. It is probable that this is the nature of the process in cysto-sarcoma of the mammary gland. In the case of the *villi* of the *placenta*, or of the minute, normal, clavate extremities of the choroid plexuses in the brain, pedunculated cysts may be formed by the hypertrophy of the cellular tissue of which they are composed, and a hydropic degeneration of the intercellular fluid.

This is not the place to enter upon the individual peculiarities of the anatomical structure of cysts, and the mode of formation deduced therefrom. This belongs to the Special Part of the work. We have deemed it necessary here to propound a theory of the formation of cysts, regarded from a general point of view, and think that it recommends itself by the simplicity and congruity of the explanation it affords of these complex pathological structures. It corresponds, to some extent, with C. Bruch's notion, who says, that all cysts, without exception, owe their origin simply to an accumulation and deposition of the contents of whatever kind in the *parenchyma* of the organs and tissues; and, consequently, that not only does no cyst proceed from a parent-cell, but, also, that no cyst, which does not correspond to a pre-existing *areola*, can, as such, be an independent structure. According to him, the contents would be the primary, and the wall the secondary element in the formation of the cyst. C. Bruch's theory of cysts, and our own, are thus opposed to that of Rokitansky, who regards the cyst, from its organization and (secretory) function, as a definite hollow structure, whose essential rudiment is a determinate substantive element. The elementary granule grows by intersusception, into a *nucleus*, and this, in the same way, into a structureless vesicle, which may attain to a diameter of from $\frac{1}{25}$ to $\frac{1}{10}$ mm. To the cyst, in its primitive condition as a structureless vesicle, there is superadded, on the exterior, a more or less distinct fibrous layer, which coalesces with the wall of the cyst. Thus, the cyst, in the secondary condition, is constituted of a wall of a definite tissue, lined on the inside with *epithelium*, and is forthwith capable of attaining to even a monstrous growth. In order to explain the nature of com-

pound cysts, Rokitansky was obliged to adopt the supposition of an endogenous multiplication of the vesicles; asserting, that new cysts are developed in the fluid, or in the parenchymatous contents of a cyst, by the enlargement of the *nucleolus* into a structureless vesicle. The development of these vesicles, however, is not carried beyond the primitive condition, the necessary element to be superadded to the structureless vesicle, required for its fixation and continued development, being absent.

It is obvious that Rokitansky requires several *hypotheses* for the establishment of his theory of cysts, whilst that here advocated by us, is based simply upon the anatomical structure of the normal, or of the pathologically modified, areolar tissue, and of the papillary new formations of connective tissue.

PART II.

SPECIAL OBSERVATIONS.

CHAPTER I.

§ 1. 1. FAMILY—INORGANIC FORMATIONS.

THE constituents of the animal organism exist either in a state of solution or in the fluid form, or in the solid state. The vital conditions of the animal body, however, may be so altered that one or other of its constituents removed from vital connexion with the organism, will necessarily undergo changes within it similar to those to which it would be liable were it wholly eliminated from the body, and exposed to external influences. Mineral substances, which usually occur in the state of solution, will, under these circumstances, pass from the fluid to the solid form, and may be precipitated in a more or less perfectly crystalline condition or in an amorphous state, intermixed with organic and other accidental constituents. In this condition they form white *deposits*, which, when accumulated in any situation in considerable quantity, and at the same time rendered coherent by an organic connecting medium, become *concretions*. We shall now proceed, at once, to consider the special substances.

1. URIC ACID.

This acid, in the crystallized condition, affords one of the best examples of the multiplicity of form which may be pro-

duced by various modifications of circumstances. E. Schmidt and C. Schmidt have lately made the crystalline forms of uric acid the subject of accurate investigation; and the latter especially, by rigorous and precise goniometrical measurements, has determined the axial relations of this crystalline acid.

The fundamental form is best observed when a uric acid-salt, as of potass, soda, or ammonia, is brought into contact with acetic acid. The uric, being a very weak acid, is immediately set free, and appears in the crystalline condition in the form of rhombic tables (fig. 1 *a*), whose acute angle, according to C. Schmidt = 45°. The angles, however, often appear to be rounded, and in this way are produced tables approaching the oval form; these are imperfect crystalline figures. The angles at the obtuse or at the acute corners of the rhombic tables are often truncated, when a hexahedral figure results. An octangular table will be formed when both the obtuse and the acute angles are thus truncated, which are thus usually rendered more or less inapparent, and the oval form above noticed arises. It not unfrequently happens that two or more tables are superimposed one upon another, so as, when viewed on the side, to form a rectangular line of steps. It very often happens that the fundamental table upon which the others are heaped is bounded by sharp contour lines, whilst the superimposed layers are more or less fissured and jagged; they may also be deposited only on the one or other half of the table.

Fig. 1.

The term rhombic table is employed as a useful expression of the idea of flatness, but it is at once obvious that each of these tables must have a certain elevation, and might therefore more properly be described as a much depressed rhombic prism. That this is the case is more distinctly obvious in fig. 1 *b*, with the shaded lateral planes. Before going further, we are here compelled to remark upon a circumstance which is seen

with especial distinctness in transparent crystals viewed in the microscope by transmitted light. If the position of the crystal be such that the transmitted rays of light strike its surface at a right angle, or in other words, if its position be perfectly horizontal, we shall, in the microscope and by transmitted light, perceive only the rhombic figure. But immediately the position of the rhombic prism is rendered slightly oblique, it becomes possible for us to see the lateral planes; and we shall, in fact, perceive not only the lateral planes of one side, as by reflected light, but by changing the focus, those of the opposite side also, by means of the transmitted light. This circumstance alters, to some extent, the external aspect of the crystal, when delineated by transmitted light; and it is often a nice matter, especially in the complex crystalline forms, to arrive at a correct judgment. The study of crystals in various positions is therefore indispensable.

What has been said with respect to the altered forms of the rhombic table in the series *a*, of fig. 1, is equally applicable to the series *b* (the rhombic prism with shaded lateral planes). In this form also the angles appear to be horizontally truncated, or more or less rounded off, so that at last a barrel-shaped figure is produced (*vid.* the second crystal in the series *c*). The edges frequently lose their sharpness, and become faintly toothed, or undulating. When laminated, as they not unfrequently are, (*vid.* the first crystal in the series *d*, fig. 1,) they represent a much elongated, cylindrical body, with crystals projecting on the surface. In the same series, *d*, are two other crystalline groups, the one consisting of minute radiating crystals, the other of larger crystals heaped together. A more rare form has been described by Scheerer; this is a hexagonal pyramid, produced by the acumination of a vertical prism, which forms its base.

The dimensions of uric acid crystals differ very considerably, depending, like their form, upon the degree of concentration of the fluid, the temperature, the surface of contact with any solid body, &c. All these varieties, also, may be shown on the small scale by a modification in the mode of preparation. For instance, whether the crystallized uric acid be combined with potass, soda, or ammonia, on three separate object-glasses, and a drop of dilute acetic or muriatic acid be added to each, or the solu-

tion be previously heated, &c. It is consequently to be expected that, in the urine of diseased persons, very various forms of uric acid will be precipitated, according to the various changes in the conditions. The great mutability of form assumed by uric acid, may also be employed very usefully to establish its presence chemically, for if doubtful or indistinct forms of this acid are treated with potass or soda, upon the addition of acetic acid to the solution, characteristic crystals of uric acid will at once be obtained. If those crystals be selected, which constitute the lateritious sediment in the urine of febrile patients, in rheumatism, gout, &c., they invariably exhibit a yellow or yellowish-red colour, derived from the colouring matter of the urine, and not belonging to the crystals in the pure state.

With respect to the genesis of the crystals of uric acid, C. Schmidt states that, if the acid be dissolved in the smallest possible quantity of soda or potass, and a drop of the solution be placed under the microscope with some acetic acid, the following phenomenon will be observed: at the moment the two fluids touch each other a sudden precipitation takes place of globules about 0·007—0·006 mm. in diameter, which exhibit the Brownian molecular movement; this is seen particularly well when the acid is so applied that the two drops are approximated as closely as possible without actual contact. The acetic acid, slowly evaporating, decomposes the uric acid salt, gradually from the periphery to the centre of the drop, and an abundant precipitate is formed, of white, spherical molecules of uric acid, which are readily distinguishable from the globules of carbonic acid evolved at the same time from the superfluous carbonate of the alkali employed, by the sharp contours (strong refractive power) of the latter, as viewed by transmitted light, and their greater delicacy as seen by direct light. The molecules in question, as the molecular movement becomes weaker, gradually coalesce into spherical masses, which assuming an oval shape and becoming more and more transparent, ultimately assume the form of hexagonal tables, or of short vertical prisms, having tables of that form for their bases. By slow precipitation, caused, in this way, by the vapour of the acetic acid, the original globules increase in size; a few only unite to form such an embryo, as it were, of a hexagonal prism; or even

single globules may, not unfrequently, be seen to assume an oval form, like that of the blood-corpuscle of the Frog, from which the six angles continue to project more and more until the perfect form is produced.

Very remarkable also, is another experiment instituted by C. Schmidt, with respect to the formation of the crystals of uric acid. He placed a drop of a concentrated solution of uric acid, heated to 100°, under the microscope, and whilst still hot, if he then touched its border with any cold object, such as a wire, or glass rod, or, best, with the latter dipped in ether, rhombic prisms were formed at the point of contact; these increase in size, and up to a certain moment present a perfectly regular form; suddenly they seem to be covered with a veil, become fissured and clouded, breaking up into innumerable rectangular, distinct crystals, each of which, continuing to enlarge, forms a regular rectangular parallelopidon. C. Schmidt properly regards this phenomenon as of the highest interest, as it is witnessed in the process of formation of very various crystals, and proves that their formation is governed by a law, in obedience to which the crystal must intrinsically pass through a morphotic process, apparently in no way conducive to its further development, prior to the commencement of the actual completion of the later permanent form. In this formative process, therefore, we may perceive the indication of an analogy between the modes of formation of inorganic and of organic bodies.

Lehmann has never been able to detect ready formed crystals of uric acid in perfectly fresh urine, notwithstanding the frequency with which he has met with it in urine which has stood for an hour or longer. According to him, in the majority of instances the uric acid is formed from the urate of soda, after exposure of the urine to the atmosphere, and in fact, in consequence of a process termed by Scheerer "[acid] urinous fermentation." Lehmann has seen free uric acid passed with the urine directly from the bladder only in cases of the so-termed calculous diathesis, or when vesical gravel already existed.

Strahl and Lieberkühn have detected uric acid in the blood, both in the healthy and diseased condition, and particularly after extirpation of the kidneys. Garrod has always found uric acid [in the form of urate of soda] in the blood of persons

labouring under gout; and in patients subject to chronic gout, with tophaceous deposits, the uric acid is always present in the blood, and deficient in the urine, both absolutely, and relatively to the other organic matters; and the chalk-like deposits appear to depend on an action in and around the joints, &c., vicarious with the "uric-acid-secreting," function of the kidneys.[1]

In "Bright's disease," or in the *albuminuria* after *scarlet fever*, he met with uric acid in the blood, when the function of the kidneys was much interrupted, often even in as great quantity as in gout; in other cases the amount was less in those diseases, although always exceeding that which exists in the normal blood. In *acute rheumatism*, on the other hand, according to him, the blood never contains more uric acid than it does in a state of health. Lehmann has confirmed these experiments of Garrod, from his own researches.

The chemical theory with respect to the origin of uric acid, and its application to the increased secretion of that principle in many diseases, does not belong to our subject.

2. Urate of Ammonia.

The morphological properties of this salt afford no decisive characters by which it can be recognized. Under the microscope it appears, when formed by the decomposition of a hot solution of urate of soda by an ammoniacal salt, as a very fine pulverulent substance, agglomerated into groups, and causing a considerable turbidity of the fluid.

It may not unfrequently be observed in the form of pigment—like black specks in the medullary substance of the kidney, especially in children in the first years of life. To the

[1] [The discovery of the presence of uric acid in the perfectly healthy human blood appears to be due to Dr. Garrod, for Strahl and Lieberkühn, failed equally in detecting it, in the blood of men and of birds, though they appear on one occasion to have found it in the blood of a Dog. With this exception, they never observed uric acid in the blood, unless after extirpation of the kidneys. Dr. Garrod's observations, in which the above discovery is announced, are contained in the 'Med.-Chir. Trans.,' 2d ser., vol. xiii, p. 88 (1848), and in a recent communication (Ibid., vol. xix, p. 49, 1854), he gives another mode of ascertaining the presence of uric acid in the blood, which he says, may be readily employed by every medical practitioner, and which has the advantage of requiring for its performance, the abstraction of only a very small amount of blood.—Ed.]

naked eye, the urate of ammonia in that situation appears in the form of orange yellow streaks, radiating from the renal papillæ; when the substance of the kidney is squeezed, it appears as a very fine powder, coloured, without doubt, by the colouring matter of the urine and suspended in the expressed fluid.

If a vertical section of the kidney in which the salt is deposited be examined by transmitted light, and under a low power, the urate of ammonia will be seen in the form of divergent, jagged, broad, black streaks, among the radiating *tubuli* (fig. 2, *a*), from which lateral branches and twigs are given off at acute angles. If a stronger magnifying power be applied, it will be seen that the black substance is composed of tolerably large molecules with a polygonal contour, and aggregated into little opaque masses disposed in rows. The dark substance rapidly disappears under the influence of potass or soda, and is unchanged on the addition of acetic acid, and it is not until after the application of heat that minute, ill-formed, rhombic and hexagonal tables (uric acid) are formed. The murexid test shows, at the same time, the characteristic reaction of uric acid.

FIG. 2.

Urate of ammonia is deposited in many kinds of morbid urine, when left at rest, also in the form of globules (fig. 3, *a*) which arrange themselves together in various ways, and exhibit some resemblance to the spores of *fungi*, with which, however, on closer examination they can never be confounded, inasmuch as the spores present a nucleus, and are not altered after the addition of potass or soda.

FIG. 3.

According to C. Schmidt, the deposit formed by this salt undergoes no change after long standing in the cold or warmth,

nor has he ever chanced to perceive isolated crystals, or, at most, only a crystalline form of the smallest molecules or agglomerated spherical masses. Lehmann states that he has occasionally noticed extremely fine points projecting from the spherical mass. The latter author has rarely found urate of ammonia forming a sediment even in alkaline urine. In alkaline urine, even passed by persons suffering from injury to the spine and consequent paralysis of the bladder, he has but very rarely observed such crystalline masses of urate of ammonia. In alkaline urine, passed under other circumstances, such a product, according to him, is never found at all.

3. Urate of Soda.

The crystalline forms of this salt are usually fine needles, whose figure cannot be more precisely given; they occur grouped together in a radiating manner, and are occasionally very slender and short (fig. 3, *b*). The salt, however, also crystallizes, though more rarely, in hexagonal prisms, and thick, six-sided tables, which might be confounded with crystals of uric acid. The reaction with dilute hydrochloric acid, in which the former are dissolved and the latter remain unchanged, will determine their true nature.

It is well known that the occurrence of urate of soda in the sediment in acute febrile affections, was regarded as a rare phenomenon. But it has been fully demonstrated by Heintz and especially by Lehmann,[1] that this sediment consists of urate of soda mixed with very small quantities of urate of lime and urate of ammonia. In the "chalk-stones" of gout, yellowish-white concretions, the fascicular needles of urate of soda, occur in very great number. Garrod asserts that the blood in gout contains uric acid in combination with soda, and that this salt may be thence obtained in the crystalline state.

4. Hippuric Acid (Uro-benzoic Acid).

According to C. Schmidt, this acid belongs to the rhombic system. In form and aspect, the crystals are very like those of the triple phosphate of ammonia and magnesia, when the

[1] Lehmann, 'Phys. Chem.' (English translation), p. 214, who adverts also to the simple method of ascertaining that the sediment consists of urate of soda, afforded by the circumstance, that it dissolves at a temperature of 50°.

latter, obtained from dilute solutions, by spontaneous evaporation, are formed slowly and regularly; on the other hand, they may be confounded with the hexagonal tables of uric acid, or even with the crystals of *urea*, which latter are distinguished from those of hippuric acid by their sparing solubility in water. Hippuric acid has been known by Liebig to exist in the normal human urine; although, before it was found there, Lehmann had ascertained its presence in diabetic urine, in which, according to him, it may be demonstrated far more readily than in other kinds of urine abounding in extractive matter. In morbid urine he has almost invariably met with it, and especially, in large quantity, in the acid urine of fever. Pettenkofer found a very extraordinary amount of hippuric acid in the urine of a young girl affected with *chorea*. It has not, as yet, been found elsewhere than the urine.[1]

5. Urea.

The crystals of urea assume the form of vertical prisms of various sizes, and either pointed or flattened. The angles are occasionally truncated; frequently, also, several thin plates are superimposed one upon the other. A well-known reagent for *urea* is nitric acid; the morphological relations of nitrate of urea, therefore, are of especial interest, to enable us to obtain a crystallographical proof of the presence of that principle. The rhombic octohedrons and hexagonal tables of nitrate of urea may be confounded with the nitrates of potass and soda; and although the latter salt, by its ready solubility in water, is easily distinguished from the nitrate of urea, the distinction from the nitrate of potass still remains to be made. Under these circumstances, therefore, we are deprived of the aid to be derived from the form merely of the crystals.

Oxalate of *urea* is readily thrown down in the crystallized state, from urine evaporated to about one half, or from the alcoholic extract of the concentrated *residuum* of urine, by oxalic acid, in the form of fascicular needles and plates. It may be confounded with the acid oxalates of the alkalies and alkaline earths; and, according to C. Schmidt, is recognized,

[1] It has been discovered in the blood of oxen, by Verdeil and Dollfuss. (Lehm., 'Phys. Chem.' (Eng. trans.), vol. i, p. 197.)

by incineration on a narrow strip of platinum foil or of flattened platinum wire, which is then immersed in acid and viewed under a low magnifying power; if nothing remain, it is oxalate of urea; if globules of carbonic acid are evolved, it was an oxalate of one of the earthy or alkaline bases.

6. Phosphate of Magnesia,

May be obtained in the crystalline form, when dilute solutions of phosphate of soda and sulphate of magnesia are brought together and allowed to evaporate gradually. The crystals thus obtained, according to C. Schmidt, are hexagonal, vertical prisms, with inclined terminal faces. They are of trifling interest to us, since the phosphate of magnesia, very probably on account of its great solubility, has never been observed in urinary sediments; and is said to occur only occasionally, together with phosphate and carbonate of lime, in the arteries, membranes of the brain, and of the *uterus* and *ovary*, in an uncrystallized condition.

7. Phosphate of Magnesia and Ammonia (triple phosphate).

This salt, on account of its frequent occurrence in pathological secretions and excretions, is of the highest importance. The crystalline forms are extremely numerous, depending upon the conditions under which the crystallization takes place. The imperfect forms usually appear foliated, and the borders of the four opposite conjoined plates are sometimes smooth, sometimes irregularly toothed.

At the commencement of the crystallization,—that is, at the moment when a solution of phosphate of magnesia is brought into contact with an ammoniacal salt (of course under the microscope),—C. Schmidt observed the formation of regular tetrahedrons with angles of exactly 60°. These crystals become flattened, and the border more and more thickened; the original tetrahedrons being metamorphosed into three-sided prisms with straight or inclined terminal faces. According to him, this metamorphosis presents the only instance of dimorphism at the first origin of the crystal, other conditions being equal; it is a morphological

transitionary period, or stage, whilst all other known examples of a double crystalline form proceed simultaneously, and the development of one form or the other is determined by various external circumstances, such as differences in temperature during the formation, or subsequently influencing the already formed individual.

The fundamental figure is the rhombic vertical prism. The usual combinations are exhibited in fig. 4, and arise in consequence of a symmetrical or unsymmetrical flattening of the corresponding edges or angles; the common sarcophagus-lid forms of the triple phosphate are shown in the middle series (fig. 4), from left to right in the first and second; these are hemihedral forms, which may be further metamorphosed by the truncation of the angles. More rare, remarkable crystalline forms of triple phosphate have been described and figured by E. Schmidt; they bear some resemblance to the quadrat-octohedrons of oxalate of lime. Dilute acetic acid must, therefore, be employed to distinguish them, in which the crystals of triple phosphate are very readily soluble.

Fig. 4.

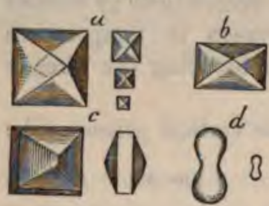
It is well known that this salt is to be regarded as the accompaniment of the process of decomposition in the animal organism. In the motions passed in typhus fever, on the surface of which it forms a crystalline pellicle, it was for a long time regarded as a diagnostic character by Schönlein and his followers, until it was shown to exist in very many other situations, where, in the process of putrefaction, phosphatic salts came in contact with compounds of magnesia and ammonia.

8. Oxalate of Lime,

Crystallizes principally in the form of an obtuse square octohedron (fig. 5 a), which is seen in various sizes down to an

almost imperceptible minuteness. This form is usually compared with that of a folded envelope; and the acutely-pointed, white *striæ*, crossing at a right angle, are caused by the planes of the pyramids on both sides, and which, by transmitted light, are illuminated only from one direction. The larger crystals of this kind, whose basal plane is a square, and in which all the sides of the square are equal, and all the angles right angles, is more rarely met with; as are also those octohedral forms, whose basal plane is a rectangle (that is to say, having the angles equal, but only the opposite sides equal to each other), fig. 5, *b*. In fig. 5, *c*, are represented two crystals of oxalate of lime, probably a combination of the square *octohedron* with the quadratic prism; one is seen from the front, and the other on the side.

FIG. 5.



The imperfect forms of this salt are biscuit-shaped (fig. 5, *d*), and of various dimensions.[1]

The crystals of oxalate of lime are insoluble in water, alcohol, ether, acetic acid, and much diluted hydrochloric acid; whilst they are dissolved by concentrated hydrochloric and nitric acid.

The oxalate of lime constitutes a frequent sediment in the urine, though for a long time overlooked, until Dr. Golding Bird remarked its crystalline forms. Lehmann, in his numerous researches, has found true sediments of oxalate of lime to be far more rare than they would seem to be according to English observers. In the amorphous state it occurs in mulberry calculi, characterised by their nodulated surface and dark colour; and it is found not only in the urinary bladder, in the form of calculus, but, relatively speaking, more frequently in the kidneys themselves, constituting nodular, dirty grey, consistent earthy concretions. They are usually situated in the *pelvis* of the kidney between the mamillary processes, the projections of the latter corresponding to the depressions in the former. In the *pelvis* of the kidney of an individual dead of

[1] [These "dumb-bell crystals" have been supposed, by Dr. Golding Bird, to be formed of *oxalurate* of lime.—ED.]

Bright's degeneration of the gland, with pulmonary *tuberculosis*, and general dropsy, in his fiftieth year, C. Schmidt, found an oval concretion of oxalate of lime; fragments of the whitish or grey oxalate layers presented an irregular aspect, and were apparently amorphous; whilst the larger prominences on the surface of the calculus were perfect half-octohedrons with rounded edges and angles. In the atrophied kidneys of old people, dirty yellow conglomerates are occasionally met with as much as $\frac{3}{25}$ m.m. in size. In the cortical substance they present a rounded or oval form, and in the medullary are elongated; the surface is nodular and uneven, and they disappear on the addition of concentrated hydrochloric acid, without the evolution of air-bubbles. In many minute rounded concretions, acute, crystalline projections, having the form of half-octohedrons, may be distinguished under a strong magnifying power. These concretions also, therefore probably contain oxalate of lime.

The dark colour of the oxalate concretions depends, without doubt, upon pigment, which, according to C. Schmidt's correct opinion, is precipitated from the *hematin*; the mechanical irritation caused by the acute eminences of the calculus giving rise to *hyperæmia* and extravasations of blood. The blood-corpuscles undergo a gradual decomposition, the nitrogen, hydrogen, and oxygen escaping, in consequence of which the proportion of carbon in the pigment becomes more and more considerable. He considers that, in this instance, as in that of the occurrence of other black and brown pigments in pathological cases, there is obviously set up a slow process of decomposition of the *hematin*.

9. Carbonate of Lime.

As a pathological deposit, this salt never occurs in the crystalline, but always in the amorphous condition, assuming either the nodulated form or that of white opaque masses, which may be broken up into a fine powder. At the same time it is usually combined with a larger or smaller quantity of phosphate of lime. The nodules form rounded botryoidal eminences (fig. 6, *a*) rising from a common homogeneous mass, and retaining a certain degree of transparency. In the instance here represented, they were obtained from the inner aspect of the posterior

capsule of a cataractous crystalline lens of an old Horse, and were loosely imbedded in the form of larger or smaller particles in the atrophied substance of the lens. Under a stronger magnifying power, it was possible, in this case, also to observe the minute deposits of which the masses in the aggregate were made up (fig. 6, *b*); these were sometimes isolated, sometimes grouped granules, from about the diameter of a blood globule, down to indistinguishable molecules. The external contour of each granule is more rarely circular, usually reniform or having several protuberances, owing to its being constituted by the coalescence of several granules, and surrounded by a dark border. The central part of the granule is transparent, and, in its mode of refracting light, bears some resemblance to that of a fat-globule. If several of these layers are superimposed one upon another, it is obvious that they must darken a considerable part of the field of view. In larger masses of crystals, a concentric lamination or streaks radiating from the centre, may be perceived.

Fig. 6

a

b

The origin of the granular deposit is most probably to be sought in the rounding off of the edges and angles of the crystallizing carbonate of lime. So far as is known, the latter in a composite crystalline form (six-sided prism with six-sided pyramids), occurs in man, and the mammalia, only in the labyrinth, forming the so-termed "otolithes."

It is always requisite, in conglomerates of this kind, to notice the reaction of an acid, under the microscope, in order to ascertain whether the particle submitted to examination disappear with the evolution of air-bubbles or not. The effect of dilute acetic acid upon the crystals of carbonate of lime is interesting, the latter constantly diminishing with the evolution of bubbles of carbonic acid, though still retaining the characteristic crystalline form, until they gradually melt away equally on all the surfaces, and are reduced to a mere point, the outlines of which are at last no longer distinguishable. If the acid be added to amorphous carbonate of lime, the development of carbonic acid is at first very vehement; the air-bubbles may be

seen making their way through the fissures of the concretion, and in their passage, on account of their elasticity, assuming the form of the cavity traversed by them; but they always retain their peculiar, dark, abruptly defined borders. So soon as the gaseous carbonic acid has quitted the periphery of the conglomerate, and come into contact with the surrounding, mainly watery fluid, it expands uniformly on all sides, and assumes a spherical shape. The gas-bubbles, thus formed, rise to the surface of the fluid covered by the glass, and are enlarged by the addition of others.

The morphological conditions of these gaseous bubbles are identical with those of air-bubbles; they present a dark border, abruptly defined on the exterior, which, owing to the imperfect achromatism of our instruments, is surrounded by a slightly coloured luminous haze, and in the centre, in a certain position of the focus, may perhaps exhibit a well-defined white ring. Towards the interior of this hollow spherule the dark border is not sharply defined, but gradually fades off into the brightly illuminated central spot, and there presents a greenish red colour.[1]

If dilute sulphuric acid be employed as the re-agent, the formation of crystals of sulphate of lime will at once be observed, to whose forms we will advert more fully below.

Carbonate of lime occurs only very rarely in urinary sediments and *calculi*, at any rate in man; in herbivorous animals, deposits of this salt are in general more abundant. It will very frequently be observed in old exudation-membranes, fibrous tumours, &c., imbedded in the organic substance.

10. Sulphate of Lime.

Chemists make no mention of the presence of this salt in urinary sediments, and the various kinds of concretions; consequently, in the crystalline form, it is of interest to us only with respect to the circumstance, as above noticed, that it always appears in the reaction of sulphuric acid upon carbonate of lime. In this case, radiating bundles of minute acicular crystals are immediately formed, resting upon the main mass, and which are

[1] [This chromatic defect, at any rate, cannot be said to exist in our object-glasses.—Ed.]

so small, that no precise determination of the form of the crystals can be arrived at. Those crystals which are subsequently formed more slowly, are of larger size (fig. 7), and may be recognized as consisting of numerous, oblique, six-sided columns with occasionally truncated angles and edges. Twin-crystals, also, may frequently be noticed.

FIG. 7.

11. PHOSPHATE OF LIME,

Occurs in all pathological deposits only in the amorphous condition, as a coherent, finely granular, opaque substance; but the opinion occasionally expressed, that it is never obtained in the crystalline condition is erroneous. With respect to this point, C. Schmidt relates the following experiment: "On bringing together soluble phosphates and calcareous salts, as, for instance, phosphate of soda with chloride of *calcium*, a gelatiniform, perfectly amorphous precipitate of phosphate of lime is thrown down. This precipitate, after some days, becomes more and more transparent, not unlike thick mucilage of gum or dextrin, and opalescent; in direct sunlight the varying reflexion of the luminous rays renders visible, innumerable, delicate, flickering crystals into which the amorphous precipitate has become transformed, apparently without any change of its chemical constitution. Examination by the assisted eye confirms the correctness of the observation; the microscope showing innumerable, excessively slender and delicate rhombic tables."

Phosphate of lime is a frequent ingredient in urinary sediments, and, owing to its amorphous condition, presents no positive morphological character. We are compelled, therefore, to distinguish it by the use of acetic acid, or still better of hydrochloric acid, in which it is more soluble than in the former; the non-evolution of gaseous bubbles distinguishes it under these reagents from carbonate of lime, and the non-appearance of

crystals of uric acid, from any urate. In order to display it when in connexion with organic substances, more distinctly, a solution of potass or soda should be employed, in which it remains as an insoluble residue, whilst the organic matter is rendered hyaline.

In cases where deposition of carbonate and phosphate of lime has taken place, it is a nice question to determine whether it is situated in the cells of the *parenchyma* or in the intercellular substance. C. Schmidt has broached the proposition that the phosphate of lime stands in very intimate relation to the process of cell-formation in the plant; he has never found so-termed "cretifications" of phosphate of lime in the vegetable cell, whilst the oxalate, sulphate, and carbonate of lime are frequently deposited therein in the crystalline form. We leave the universality of application and the correctness of this proposition undetermined, as at present we are not in possession of sufficient means by which to recognize phosphate of lime; and for the same reason we regard the opinion expressed by Lehmann, that phosphate of lime is deposited in many, pathologically degenerated cells in the animal body, as at present without due confirmation. Notwithstanding this, however, we consider it as highly probable that the two salts in combination are deposited in the form of crumbly masses, in the cartilage and bone-cells of atrophied, cartilaginous and osseous tissue, under particular circumstances which will be discussed hereafter.

12. Easily soluble Salts.

Under this head we include the hydrochlorates, sulphates and phosphates, which are met with, contained in solution in pathological fluids. It is to be regretted that microchemical analysis and morphology can at present contribute nothing towards the scientific determination and separation of these compounds, for the crystalline forms obtained by the spontaneous evaporation of the solution are too indeterminate for the purpose. Nevertheless, in adverting to their forms, we would merely indicate the possibility of ascertaining the presence of these salts in general. The imperfect crystalline forms presented by those having as their bases soda, ammonia, potass and magnesia, are of such a kind that from a

straight main line branches are given off at an angle of about 45°, or at a right angle, (figs. 8 & 9), upon which, again, secondary

FIG. 8.

FIG. 9.

branches are disclosed at similar angles. The edges and angles in the larger crystals are so much rounded off, and in the smaller ones so minute, that a goniometrical estimation of them is impossible. Occasionally, minute cubical crystals may be distinguished, identical with those of common salt or hydrochlorate of ammonia. All of these exhibit a great tendency to dissolution, and their dimensions are less in proportion to the rapidity of the crystallization.

J. Vogel considers it probable, that in certain cases, precipitations of these soluble salts may occur, even in the living body, in consequence of the concentration of the fluid. After the internal employment of sulphate of magnesia as a purgative, he has observed microscopic crystals of that salt in the liquid motions.

Even in concretions, precipitates of soluble salts are sometimes met with, together with phosphate and sulphate of lime. F. Boudet's statement that a large quantity of salts readily soluble in water (chloride of sodium, sulphate, and phosphate of soda), occurs in such concretions, is so far supported that Schlossberger has found in a *phlebolite*, a considerable amount of a soluble salt—phosphate of magnesia; and Landerer in the vesical calculus of an Arab stallion, has demonstrated the presence of even 16 per cent. of the same salt.

13. Fat.

Of the compounds of the fatty acids with organic bases, the one of most interest, as respects our subject, is *olein*, the principal constituent of the fat in many pathological structures. Its chief morphological character consists in the circumstance, that, when made into an emulsion, it is subdivided into microscopical fat-globules, which may be made the subject of observation. The suspended fat-globules present a dark, externally well-defined, comparatively broad border, in which the white ring above-described as existing in the air-bubble, is never seen. The outer contour of the dark border forms a clear, usually reddish or greenish circle, which is, of course, the more intense the less perfect is the achromatism of the instrument; it is never absent.[1] Towards the centre of the floating globule, the contour of the dark border is rather less sharply defined, as it passes gradually into the illuminated central part. The opalescent brilliancy, as it may be termed, is often coloured,—yellowish, yellowish-red, according as there is more or less colouring-matter mixed with the suspended fat. The size of the globules depends upon the minuteness of the subdivision of the fat. If fluid fat be carefully triturated with vegetable mucilage, the fat-globules are rendered so much the smaller. Ultimately, they appear, only in a certain focal distance, as brilliant molecules, on account of the strongly refractive property of fluid fat; and when their diameter is below 0·005mm, they are found to exhibit an active molecular motion. If water be added, the fat-globules rise to the surface, and, consequently, at a certain focal distance, a mass of fat-globules may be perceived; whilst, unless adherent to other solid particles, they will not be seen at a greater depth.

The fat-globules present a different appearance when they are compressed, as may be effected by the abstraction of the fluid in which they float (as by its evaporation). Under these circumstances, they run together, assume very irregular shapes, and, at the same time, lose their sharply-defined contour.

Similar changes take place when the surrounding fluid is treated with acids,—as, for instance, with acetic acid.

[1] [When the object-glass is perfectly achromatic, it is needless to observe that these oil-globules have no coloured border.—Ed.]

When fat, in the form of globules, is lodged among the tissues, it is most easily brought into view, if the latter are rendered transparent by a dilute solution of potass or soda.

The question, as to whether the fluid fat is simply deposited in the intercellular fluid, or also within the elementary organs themselves, has already been decided in the General Part, since we have established the fact, that an accumulation of fat-globules takes place in the contents of cells undergoing involution; stating, at the same time, the morphological and micro-chemical reasons which have induced us to arrive at such a conclusion.

With respect, then, to the ascertaining of the mode in which the pathological deposition of this fat is brought about, we protest, *in limine*, against the notion that a protein-compound can be directly metamorphosed into fat; and we, therefore, employ the expressions of "fatty metamorphosis" and "fatty degeneration," only as importing a change of kind in the cell-contents and in the intercellular substance.

It must be regarded as a positive fact in organic chemistry, that the fatty matters are conveyed to the animal organism, not only in the vegetable and animal alimentary substances, but also that fat may be formed within the animal body out of hydro-carbons (as starch, sugar). An abundant source of fat is thus afforded to the organism. Fat exists also in the nutritive fluid, the blood, in the chyle, and in the lymph. That fat plays a certain part in the processes of nutrition and propagation of the cells is obvious from the experiments of Tiedemann, Gmelin, and Magendie, who fed animals exclusively upon protein compounds,—as *albumen*, *fibrin*, and *gelatin*,—that is to say, upon substances containing no fat; in consequence of which, they observed the death of the animal by hunger. A pathological proof of the importance of fat in the formation of cells, is afforded in those forms of *cancer* which abound in cells, and which, at the same time, contain an abundance of fat; all plastic exudations also contain more fat than the aplastic; the latter—as, for instance, serous fluids,—may occasionally contain a considerable amount of *cholesterin*, but very little true fat (Lehmann). At the same time, the fatty contents of an exudation cannot be regarded as affording a measure of the subsequent cell-formation.

This being the case, we shall not be surprised, in the

instance of a very profuse cell-formation, at meeting with fat, not only in the intercellular fluid, but also enclosed in the cells themselves.

It is also probable that, in anomalous conditions of the general process of nutrition, fat may be deposited in the tissues. We have already said that the blood, particularly in old persons, may contain an undue amount of fat; and that a nutritive fluid of this kind imperfectly suffices for the restitution of the cells, whence an atrophy of the latter ensues; and, in this case, they manifestly contain fat in their interior.

A second compound of a fatty acid with an organic base is *margarin*, which, as is well known, exists in the human fat-cell in combination with *olein* or *elain;* it crystallizes in fine soft needles, forming stellate groups. A definite morphological distinction between the crystals of *margarin* and of its fatty acid,—*margaric acid*,—cannot be laid down, since the individual crystals are so minute as to render their determination impossible. The distinction indicated by C. Schmidt, that the crystalline needles of *margarin* are shorter, and not so distinctly formed, as those of margaric acid, is one only of degree, and, therefore, insufficient; nor are we at present well enough acquainted with the crystalline relations of perfectly pure *margarin*. According to J. Vogel, the crystals of margaric acid may be chemically distinguished from those of *margarin*, by the circumstance, that the former are at once dissolved by boiling in weak spirit, and the latter only upon the application of strong alcohol.

Margarin and margaric acid undoubtedly crystallize under certain conditions (*lipoma*) during life, and may easily be obtained artificially, simply by the cooling of the fluids which contain the *margarin* in the state of solution. They are found, therefore, very distinct, in fat-cells artificially cooled, whilst they are not met with in the same cells in the recent condition. Margaric acid occurs, not only free and crystallized, but also in combination with alkalies, forming margarates. Margarate of lime has been found in concretions.

Cholesterin is characterised by the form of its crystals; which are thin rhombic plates, whose angles were found by C. Schmidt to be invariably in the proportion of 79° 30′ to 100° 30′, whence no mistake in their determination can arise. It is self-evident

that in an inclined position of the crystal, when it is not lying horizontally, the acute angle may appear to be diminished, and the obtuse rendered larger, as may be noticed in several of the plates represented in fig. 10 (*vide* also the figures of *cholesterin* plates in *cholesteatoma*). The crystals are of very various dimensions though always retaining the same proportional angles; and they are very transparent, so that when present only in a single layer they may readily be overlooked. Many exhibit a truncation of one of the acute angles (fig. 10, in the centre crystal at +), and the angles between the side thus formed, and those of the fundamental figure, according to C. Schmidt's measurements, are pretty nearly equal to each other. That this truncation of the acute angle, does not represent any accidentally injured form, the possibility of which must be admitted, is obvious from the frequent occurrence of plates of this shape, but mainly, from the constant, well-defined proportions of the angles formed between the truncated side, and those belonging to the fundamental form.

Fig. 10.

The plates of *cholesterin* are frequently superimposed one upon another, in such a way that the corresponding sides are applied one above the other. Smaller plates, also, being frequently intercalated (fig. 10, *a*). In the majority of crystals, however, the direction of the sides of the superimposed plates is irregular (fig. 10, *b*), in consequence of which the angles and sides appear broken, fissured, and jagged. But even in these irregular, fragmentary aggregations, usually two remaining uninjured sides of the rhombic plate with one of the angles above-mentioned, may be discerned, so that even from these incomplete forms, the diagnosis of *cholesterin* may be satisfactorily made. The laminated tables of *cholesterin*, viewed under the microscope, by reflected light, afford a very beautiful play of

colours, evidently dependent upon the interference of the luminous rays. Occasionally they are imbued with a deep or brownish-yellow colouring matter.

Cholesterin is insoluble in water, acids, and alkalies, which last property may be made use of to render more distinct, plates of this substance when imbedded in the tissues (by means of potass or soda), and soluble in alcohol and in ether, from which it crystallizes again. It may be regarded as an indifferent non-saponifiable fat, which, from the nature of the products of its oxidation, according to Redtenbacher, approaches nearest to the non-nitrogenous constituents of the bile. Lehmann is of opinion that it should not properly be associated with the fats, regarding it as being probably a product of decomposition. Its import, looking at its wide destribution in the organism, is still enigmatical.

Pathologically, *cholesterin* is often accumulated in large quantity. Becquerel and Rodier have found an increased quantity of it in the blood of old persons, and in most acute diseases very soon after the invasion of the fever, especially in inflammation and jaundice. According to Lehmann, *cholesterin* is an integral constituent of pus. In gall-stones, the so-termed *cholesteatoma*, hydatids, follicular tumours, ovarian cysts, in the atheromatous deposits in the walls of the arteries, in cancerous tissues undergoing involution, &c., we often meet with an astonishing quantity of *cholesterin*.

14. Colouring matters.

We shall here especially notice the principle termed *hematoidin* (*xanthose*), which is formed from the *hematin* by a mode of transformation not as yet investigated. The crystalline form of *hematoidin* is the oblique rhombic prism [frequently almost perfect rhombohedra]. As in most of the crystals this prism is much depressed and almost always laid upon the broad side, the two lateral planes are usually invisible, the shaded terminal planes of the rhombic prism alone being apparent. In this way may be explained the two dark streaks along the crystal which come into view under transmitted light. The larger crystals (fig. 11, *a*) are more rare than the smaller

(*b*), the size of which may be so far reduced that they are scarcely any longer distinguishable even under the highest magnifying power, as elongated angular crystals. A more rare form is presented in the hexagonal prism (*a* +), a form analogous to the six-sided prism of the crystals of uric acid. The crystals of *hematoidin* are transparent, and of a yellowish-red colour passing into a ruby red, whence, when imbedded in the tissues, they are the more easily recognized.

G. FI11.

Under the influence of a solution of potass or soda, the crystals break up, and become, as it were, cleft into *laminæ*, but without undergoing solution even after the lapse of some time (half an hour); at the same time they may be observed to become paler. The changes of colour produced by sulphuric acid are very interesting; the solution, which results from the application of this reagent, becoming brownish-red, steel-green, blue, light-red, and yellow. This fact was noticed by Virchow, who was also the first accurately to describe the crystals of *hematoidin*. In acetic acid, alcohol, and ether, they remain unaltered. On some occasions Lehmann observed the smaller lighter coloured crystals to be dissolved by alcohol containing sulphuric acid or ammonia, and that they were again precipitated when the solution was neutralized. But this was not always the case.

Hematoidin also occurs in the *amorphous* condition aggregated into reddish-brown granules or amorphous masses, mixed with crystals, as for instance in the apoplectic cysts, as they are termed, in the brain, the large cells of medullary cancer &c.; and presenting the same changes of colour when acted upon by sulphuric acid as are witnessed in its crystals.

To a certain extent it has been proved that *hematoidin* is closely allied to *hematin* (*hematosin*, colouring matter of the blood), which when prepared artificially appears as a brownish-red powder. As regards the chemical properties of the latter substance, its ready solubility in weak alkaline solutions, is especially to be noticed, since by this it is distinguished, on the one hand

from *hematoidin*, and on the other from the fully formed, orange-coloured, reddish-brown pigment; both the latter remaining undissolved in alkaline solutions. Otherwise, however, there are so many intermediate stages between *hematin*, *hematoidin*, and fully formed pigment, in the chemical reactions above noticed, that it might at once be said—that *hematoidin* and pigment represent merely the products of decomposition of *hematin*.

The crystals of *hematoidin* are met with most beautifully displayed in sanguineous extravasations in the brain, in encephalic collections of blood, and in the so-termed apoplectic cysts, in which latter these crystals, together with the amorphous, reddish-brown *hematoidin*, imbedded in a fibrous substance, form the principal constituent. They occur, moreover, though in less abundance, in extravasations of blood in the lungs, spleen, and Graafian follicles, and in aneurismal dilatations of the arteries, filled with coagula.

Chemists have hitherto been unable to establish a theory of the formation of *hematoidin*, since the chemical composition of *hematin* itself is not as yet accurately determined, and that of *hematoidin* is still unknown. The fact, however, observed by Kölliker, that the latter principle originates within the blood-corpuscles in some fishes, places it beyond all doubt that the crystals are formed from the *hematin*.[1]

[1] [It would appear that several distinct kinds of crystals occur in connexion with the blood, either within or without the organism.

1. The *hæmatoidin* crystals of Virchow. Brilliant, transparent crystals, having the form of regular oblique rhombic prisms, and of a red colour, varying in tint and depth, according to the state of aggregation of the crystals. They are of a comparatively stable nature, and are insoluble in water, alcohol, ether, and acetic acid. And they occur either free, or enclosed in flaky particles, or in cells, exclusively in extravasated blood, which has been retained for a longer or shorter time in the organism. These crystals seem to have been first noticed by Sir E. Home, and more recently by Scherer, Zwicky, and Rokitansky, but were first accurately described and placed in their true light by Virchow, who regards them as composed mainly of a new colouring matter, which he termed *hæmatoidin*, and conceived to stand between *hæmatin* and *bilifulvin*, combined with a small amount of *protein*. And this view of the nature of *hæmatoidin* appears to be confirmed by the circumstance, that Zenker and Funke have transformed crystals of *bilifulvin* into *hæmatoidin*.

2. The "black crystals" observed by Mackenzie, Guillot, and Virchow, in melanotic deposits. These are flat, rhombic tables, with very acute angles, and resist nearly all reagents. They are probably similar in chemical composition to the above, *plus* some carbon.

3. The third kind of blood-crystals are the "globulin crystals" of Kölliker.

Nor can there be any doubt, also, that *hematin* may occur as an amorphous, dark substance, precipitated, partly within, partly without the blood-vessels.

It assumes the shape of usually rounded, occasionally irregularly angular, brownish-black corpuscles which in the aggregate represent an opaque black mass (fig. 12, *a* & *b*) and differ in size, which in the larger specimens exceeds that of the largest blood-corpuscles by somewhat more than a fourth. In the larger particles the border often appears wholly or partially facetted; the surface frequently seems to be smooth. In the corpuscles several smaller molecules may often be distinguished. The smaller form of *hematin* is constituted of scattered brownish-black granules (fig. 12, *c.*, the dark granules scattered among the lighter coloured blood-corpuscles).

Fig. 12.

Precipitated *hematin* of this kind is met with most abundantly and most frequently within the vessels of the mucous membrane and submucous tissue of the *duodenum* and upper part of the small intestine, less so in the lower portion, and

They would seem to be of a totally different nature to the *hæmatoidin* crystals, inasmuch, as they are extremely perishable, and very soluble in acetic acid, dilute solutions of potass and soda, and in nitric acid. The crystals assume divers forms, such as prismatic, tetrahedrons, octahedrons, and hexagonal tables, the shape varying apparently in different animals. These crystals seem to have been noticed at about the same time (1849), by Kölliker and Reichert. By the former, in the interior of the blood-corpuscles of the splenic vein in the Dog, and of several Fish, as well as of *Python bivittatus*, and although he had noticed their formation externally to the body, still he thought there was reason to believe that most of them were produced during life, from a sort of decomposition of the blood-corpuscles in the spleen. Reichert noticed the occurrence of similar crystals in the membranes of the *ovum* of the Guinea Pig, and indicated their composition out of an albuminous substance, &c. But the proper interpretation of their nature and constitution was reserved for Funke, who had independently noticed them in the splenic vein of a Horse, and subsequently in the blood of Fishes. He made the important observation, that they are formed only externally to the body, and that they may be produced at any time by a certain mode of procedure; and throws out the supposition, that they are formed from the albuminous contents of the blood-cells combined with *hæmatin*. It has since been shown by Kunde, and others, that the "globulin crystals" may be pro-

most rarely in the large intestine, in persons dead of cholera. The same forms frequently occur, in pretty considerable number, in the capillary system of the *vena portæ*, (*vid. sup.* on the new formation of connective tissue in the liver), in the slate-coloured liver observed in connexion with intermittent fever, as well as in the larger branches of the *vena portæ* and hepatic veins. They are also invariably found in those livers of the Rabbit which contain whole agglomerates of the ova of Entozoa together with a molecular substance, in tubercular nodules, of a whitish-yellow colour, and affording a turbid juice. The brownish-black corpuscles of *hematin* are met with in the free state around those deposits in the Rabbit's liver which have been erroneously described as tubercles. They also occur not unfrequently, in infarctions of the spleen.

With respect to the method of displaying them, it only remains to remark, that it is advantageous to treat the parts with water, in order to wash away the colouring matter from the blood-corpuscles, in which way the precipitated *hematin* is brought more distinctly into view.

Their *microscopical characters* are the following; acetic acid produces no perceptible change, dilute hydrochloric acid, after some time, renders them pale, and occasionally causes their disappearance. Chlorine-water merely produces a clearer, dirty green colour. Alcohol, ether, and tincture of iodine, cause no alteration. Potass acts in the most striking way upon them, in a solution of which they are rapidly dissolved.

With respect to the conditions under which they are developed, of course, at present, nothing determinate can be stated, this much only admitting of probable assumption, that stagnations of the circulating blood, especially after exudations, are followed by a *necrosis* of the blood, which shows itself in the form now under consideration.

The *red-colouring matter of the urine* (*urerythrin*) appears in

cured from the blood of any part of the body, and of almost of any (warm-blooded ?) animal.

4. Teichmann describes "white crystals," which are probably identical with the foregoing, minus the colouring matter.

For directions for the procuring of these crystals, consult Beale, on the 'Microscope,' and for farther particulars reference may be made to Kölliker 'Mikrosk. Anat.,' vol. ii, p. 583, et seq. *Vid.* also a paper on 'Albuminous Crystallization,' by Dr. Sieveking, 'Brit. and For. Med.-Chir. Review,' vol. xii, p. 348.—Ed.]

considerable quantity in what is termed the lateritious sediment. Scherer has rendered it probable that it has no constant composition, but that it is a body undergoing continual oxydation and of varying constitution. F. Heller has also found a blue (*uroglaucin*) and a carmine-red (*urrhodin*) colouring matter, occurring occasionally in retentions of urine, concussions of the spinal chord, and vesical catarrh. Virchow regards the *uroglaucin* as a crystalline derivative from the *hematin,* and describes the crystals of that substance, like Heller, as fine, indigo-blue, radiating needles, which generally assume a stellate form. He found their micro-chemical reaction towards the most powerful chemical substances to be different. In concentrated alcohol, according to him, they dissolve, and form an intensely blue fluid.

The chemical properties of the *colouring matter of the bile,* or *bile-pigment,* have as yet been but little investigated. With respect to it, Heintz has remarked that a solution of nitre in nitric acid produces a peculiar play of colours, including almost all prismatic colours. In jaundice, as is well known, this pigment becomes universally diffused.

Black pigment (*melanin*) appears in the form of reddish-brown molecules, which, when in a state of aggregation, are completely opaque; they are usually united into black patches by a connective material.

We have already stated, in speaking of the pigmented degeneration of the cells, that it originates most probably in a solution of the hematin. The colouring matter is insoluble in potass and acid, and is with difficulty destroyed even by nitric acid. With respect to its special occurrence in organizable or unorganizable exudations, we must refer to the chapter in which that subject is treated.[1]

[1] In addition to the above abnormal colouring matters met with in the animal organism, it must not be forgotten that certain tissues may be coloured by extraneous matters introduced in the food or otherwise. A familiar example of this is afforded in the coloration of the bones by madder; and a similar phenomenon may occasionally be observed in the adipose tissues. In negroes coming from certain parts of Africa (as about Cape Palmas), where palm-oil forms an article of diet, the fatty tissue throughout the body is sometimes of a deep orange colour; which may be shown by chemical tests, not to depend upon the biliary colouring matter; and which is not inconsistent with a state of perfect health.

15. Concretions.

Of these bodies we distinguish two groups, according to their mode of formation, the one produced from a glandular secretion, the other by a process of involution of an organized structure.

If we suppose, for instance, that the secretion of any gland be retained, in consequence of an obstruction of whatsoever kind, it will necessarily undergo metamorphosis. The solid organic constituents existing in every glandular secretion, as, for instance, epithelial cells, or the proper corpuscles belonging to any secretion, as those of the saliva, will, from their specific gravity, subside, including among them some of the soluble constituents of the secretion. The supernatant portion of the fluid is absorbed, at any rate to some extent, as elsewhere, by the veins and lymphatics, whilst the portion mechanically enclosed among the solid, precipitated elementary particles being in the state of rest, must, owing to the extensive surface afforded among the minute dead and disintegrated elementary organs, undergo a change in its state of aggregation. Consequently, the protein-compounds which exist in all secretions, though only in minute quantity, must, as well as the mineral constituents, pass into the solid state. These fundamental conditions for the origination of a concretion exist in all glands with an excretory duct. Now if a renewed secretion accumulate in the latter, the same process is repeated, and in fact, in an augmented degree, inasmuch as the already precipitated mineral constituents, owing to the affinity between similar elements, attract those in a state of solution by which they are surrounded, in consequence of which, the latter pass the more rapidly into the solid state.

The *conditions necessary for the obstruction of an excretory duct* are external or internal; that is to say, the duct may ultimately be completely obstructed by a new formation, which had previously exerted a gradually increasing compression; or the glandular secretion itself may contain an increased quantity of mineral or organic ingredients, which are precipitated the more readily when the removal of the secretion is impeded by a sluggishness of the organic muscular layer of the excretory

duct; in which ultimately a diverticular expansion may even be formed. The matters deposited in the *lumen* of the duct will also gradually conduce to the narrowing of it, and finally obstruct it completely.

Thus the fundamental requisite for the formation of a concretion in the excretory duct of a gland, is the *stagnation of the secretion*. It occurs with especial frequency in those glands, which in the normal condition are furnished with a large diverticular dilatation, as the gall-bladder in the instance of the liver, and the bladder in that of the kidneys. When the secretion in these receptacles, independently of any closure of the excretory duct, is retained, in consequence of what may be termed an intrinsic cause (want of successive contractions of the organic-muscular coat), a deposit will take place, the more readily in proportion to the quantity of epithelial cells which may accumulate from the insufficient elimination of the secretion, and the increased amount of mineral elements, or of *albumen, fibrin,* pigment-molecules, or of foreign particles which may be present, in the character, as it were, of precipitants. A particular modification is witnessed in the formation of the concretion, when the secretion already eliminated from the gland is delayed in its expulsion from the sphere of the organism, and is thus subjected to new conditions.

The *forms* of concretions depend upon the parts by which they are immediately surrounded, being regulated by the form of the receptacle in which they are lodged, and the matters already accumulated therein. The *colour,* of course, depends upon the nature of the constituents, and partly upon their arrangement. Their *texture,* as it is termed, and as displayed in sections, depends upon the kind of lamination, and the chemical nature of the various layers.

Micro-chemical examination, notwithstanding the valuable results it has hitherto afforded, is still insufficient for a complete, qualitative analysis of these concretions, we do not, therefore, think it necessary to advert more particularly to the special indications thus presented. It cannot be doubted that by cultivation of the subject in the micro-chemical direction, especially as it has been pursued by C. Schmidt, abundant results may still be expected. And the extent to which this mode of investigation has been successful, depends upon close

attention to the special morphological relations of the mineral constituents.

A greater histological interest attaches to that *special modification of formation* above adverted to, as taking place when the secretion already eliminated from the gland is still impeded in its excretion from the sphere of the organism, and becomes mixed with adventitious or foreign constituents. An instructive instance of the truth of this was afforded in the microscopic examination of an intestinal concretion, taken by H. Ulrich, from an inguinal abscess containing air. The body thus removed, according to his account, was about the size of a cherry-stone, with a rough surface, and consisted of a brown, friable *nucleus*, surrounded with a dirty, greyish-brown, also friable shell, in parts about two lines thick, and which was partially detached by the pressure of the forceps employed in the removal of the body. The separate fragments of the concretion were of a dirty grey colour, and of a loose and porous texture, so that the portions held in the forceps were, by slight pressure, easily broken up into smaller pieces. No special structure could be discerned by the simple lens. After being wetted with distilled water, the parts were easily crushed by means of the flat side of a scalpel, or by pressure upon the covering glass, into a fine powder. The microscope now showed amorphous, dirty brown-yellow, molecular corpuscles, which, when heaped together, were quite opaque; smaller and larger groups of also amorphous black corpuscles might here and there be observed. The latter were usually dissolved by acetic and sulphuric acid, in which the development of air-bubbles could be quite distinctly perceived. The application of the latter acid was followed either by the appearance of six-sided oblique prisms, after some time, or by a formation of minute stellate needles (fig. 7), according as the fragment contained more or fewer of the black corpuscles. The latter was always the case, when a large quantity of carbonate of lime was present, and the crystallization took place rapidly, whilst with a less quantity of the same salt, larger crystals were formed, which were ascertained to be sulphate of lime, under the form above noticed. The acids produced no further effect upon the dirty brownish-yellow masses; they most probably represented a biliary deposit.

The other bodies of a determinate form presented much greater interest. The most remarkable, were elongated, oval granules, of a light-brown colour, manifestly due to the colouring constituents (fig. 13 *e*). Their long diameter was to the short as 0·024—0·028 : 0·044—0·052 mm. They had a proportionately thick envelope, and at each end of the long axis a capitate projection. In the centre of the oval were numerous groups of strongly refractive granules resembling fat-globules (vitelline substance); many were empty and ruptured transversely. These were obviously nothing else than the ova of *Trichocephalus dispar*. Their distribution in the concretion was not uniform, so that in some portions of it they occurred to the number of ten and more together, whilst in others scarcely one could be found. Together with these *ova*, others also were met with of a larger size, and oval (*f*), whose long diameter was less in proportion to the shorter, or as 0·044 : 0·060 mm. The membrane was double, and there were no capitate projections, as in the other *ova;* the better preserved specimens contained, in the interior, a spherical vitelline mass. They were more rare than the former kind, and most nearly resembled the ova of *Ascaris lumbricoides*.

Fig. 13.

Besides these, decided vegetable remains were met with,—such as elongated parenchymatous cells (*a*), epidermis cells, some having a hair attached (*b*), and torn fragments of thicker or more slender spirals (*c*, *d*).

The microscopical analysis of this concretion, proved, as is obvious, that it had been formed in the intestinal canal, since the usual constituents of fæcal matters,—such as brown bile-pigment, portions of vegetable tissues,—were present in it; but, at the same time, it approximately determined the spot where the perforation of the intestine had occurred, since

the *Trichocephalus*, as is well known, inhabits the large intestine, and especially the *cæcum*.

The chemical examination of the concretion, conducted by T. Wertheim, afforded principally carbonates and phosphates,—mostly phosphate of lime—together with organic constituents.

The *second mode of formation* of concretions, consisting in a process of involution of an organic structure, depends, as is at once obvious, upon the nature of the latter. Mineral elements, chiefly calcareous salts, are deposited towards the periphery of the structure affected, and gradually occupy the whole of it more or less completely. The consequence is, that the nutritive processes in the tissue cease, and its elementary constituents become less and less recognizable, although remains of them always exist.

In the grey substance at the upper and anterior part of the right hemisphere of the *cerebrum*, was lodged a rounded, whitish-yellow body, about three lines in diameter. When cut across, it was seen to be a sacculus, with walls about one line thick, and containing a pultaceous material, which, together with glistening plates, included hard, consistent, and incompressible, little, whitish masses. The plates were very large, heaped cholesterin-tables; the white particles, black by transmitted light, were amorphous masses, composed of granules, effervescing strongly with dilute sulphuric acid, and then forming crystals of sulphate of lime. The pultaceous material contained a large uninjured hooklet of *Cysticercus cellulosæ*, together with minute, granular, jagged plates, a few granular corpuscles, and masses. The surface of this concretion presented smooth spots, consisting of dense connective tissue, and manifestly corresponded to the nutritive capsule, composed of cellular tissue, of the *Cysticercus*. The concretion was derived from the cretification of a *Cysticercus*.

The formation of concretions proceeds in the same way in an original tissue in a state of atrophy, as in a pathological new-formed structure. We shall return to the special morphological conditions, in both of these cases, and will here relate some interesting facts, which we have had an opportunity of collecting.

In an old Hen, in the inferior wall of the abdomen, there was a protrusion, about an inch in diameter, which communi-

cated with the abdominal cavity. In it were lodged two separate, soft, brown bodies of the size of a chestnut, and containing a creamy fluid. The walls of these bodies were thick, and consisted of several layers of interlaced trabecular tissue, in which carbonate of lime was deposited (as in the egg-shell). The fluid was a broken-up, molecular material, containing granular, dirty-yellow globules, of various dimensions, and corpuscles resembling fat-globules, of various forms and sizes, as in the hen's egg. The two bodies, therefore, were nothing more than *eggs*, which had become detached from the ovary, and remained in an abortive state in the abdomen of the fowl.

Fürstenberg and Fr. Müller have remarked upon the calcified, lipomatous growths which are frequently formed in the subperitoneal cellular tissue in the Horse; and which, occasionally depending by a pedicle, become detached, and appear as free concretions in the abdominal cavity. They relate the case of a Horse, in which a tolerably firm tumour, about the size of a chestnut, was situated on a slender pedicle on the mesentery, close to the ileo-colic valve. On a section, it presented a dirty, yellowish-grey colour, was of a yielding texture, and fatty to the feel. When crushed with the scalpel, it was found to be composed principally of free fat, in the form of globules, and of numerous, stellate groups of very delicate, acicular crystals, resembling those of margaric acid or of *margarin*. The more resistant portions exhibited connective-tissue fibres, together with an opaque, granular, calcareous substance, which effervesced with sulphuric acid, and formed crystals of sulphate of lime. The softer portions consisted, for the most part, of large, oval fat-cells, in considerable quantity. The case was one, evidently, of a cretified *lipoma*.

A flattened, oval concretion, about half an inch in diameter, of firm consistence, lay free in the abdominal cavity of a Horse. Its surface was uneven, and colour yellowish-white; and when a section was made, the interior presented chalky, white specks, alternating with dirty-yellow parts. The tolerably thick membranous capsule was easily removed, and consisted of fibres decussating in various directions. The cretaceous substance presented, under the microscope, amorphous black masses, which, upon the application of sulphuric acid, afforded

a copious evolution of gas, and formed crystals of sulphate of lime. The yellowish, speckled portions, after treatment with acetic acid, exhibited a considerable quantity of angular transparent plates and fatty molecules (organic remains). It was highly probable that this concretion, also, represented a cretified *lipoma*.

There is no doubt that the *lipoma arborescens* of Müller, and Rokitansky's papillary vegetations in the joints, particularly in the knee, may, by a similar process of cretification, be transformed into concretions which, when detached, will be met with free, in the cavity of the articulation, forming what are termed " loose cartilages."

The *cretifications* which take place in serous, fibrous, and elastic membranes, in false membranes, the walls of cysts, &c., will be more properly treated of when we come to speak of atrophies, exudations and new formations of cellular tissue. It may here merely be remarked that the term " ossification" has been improperly employed in this case—certainly a wholly unscientific term—inasmuch as, in these cases, nothing like a transformation into bone substance can be observed, whence it is manifest that the use of the term *ossification* is calculated to lead to a confusion of ideas.

CHAPTER II.

2. FAMILY—ATROPHIES (INVOLUTIONS).

In the general considerations contained in the former Part, it has been shown that one of the tasks of Pathological Histology is to investigate the various disturbing circumstances by which the cell-life in the normal tissue is affected. In that place also were noticed the morphological changes undergone by the cell in general, and, so far as was possible, the micro-chemical conditions attending these changes were determined. Upon these grounds a theory of involution was constructed. We have now to point out the special conditions in the tissues and organs concerned, when in the state of *retrograde nutrition*. But before doing so, we will describe the general properties exhibited in this class of phenomena.

The idea of *atrophy* cannot, any more than that of *anæmia*, be accepted as a negation in the fullest signification of the term; we are obliged to extend the application of the notion also to a merely defective nutrition, unless it be preferred to designate the latter under the name of *oligotrophy*, which in our opinion would be an unnecessary addition to pathological nomenclature.

There are two principal causes by which *atrophy* is induced: first, an atrophic condition of the blood (as a nutritive fluid); secondly, defective circulation of the blood (imperfect locomotion of the nutritive fluid) in consequence of diminished activity of the motile organs; such, for instance, as a diminution of the propulsive force of the heart, or of the elasticity and contractility of the vessels, or cessation of motion in the voluntary and organic muscles.

In the normal, nutritive conditions a certain uniformity is found to exist; that is, a uniform distribution of the nutritive material, whence both the central and the peripheral organs are developed to a certain extent, when they have reached which they become stationary. As age advances, this uni-

formity is disturbed; in many organs involution commences before it does in others, and in old age a general retrograde process is at last set up in all the organs. But even before the regular senile period has arrived, inequalities may arise in the nutrition of an organ, that is to say, an unequal distribution of the nutritive material; whence it is possible, that in the same organ or system, one portion may become atrophied, whilst hypertrophy takes place in another; or at any rate, whilst no atrophic morphological changes are there exhibited.

The *morphological changes* of organs in a state of atrophy are extremely various, being regulated by the accompanying circumstances and conditions. If the nutritive fluid be simply diverted from a part, so that it no longer flows into the capillary system destined to provide for the nutrition, the part so affected will collapse, dry, and diminish in bulk. In this case a change in the aggregation of the chemical constituents must take place, and the matters existing in the state of solution will frequently be precipitated. The soft elementary organs shrink and often appear to be entirely dissolved, for in advanced atrophies not a vestige of them can be perceived.

On the other side, a loosening up, or even an expansion of the tissues may be noticed; and there is no reason why these metamorphoses should not be enumerated under the forms of atrophy. Owing to the imperfect nutritive condition, the elasticity and contractility of the tissues affected are diminished, and the distance between the molecules of which they are constituted may be increased. It is also very probable that a decomposition of the protein compounds which are no longer employed, is set up, with which likewise the loosening up and fusion of many organs in a state of atrophy might be connected. Were the subject of the products of decomposition of the protein compounds better investigated, it might have been possible to explain the various forms of atrophies.

Atrophy is the constant concomitant of the exudative processes. The latter might even, so far, be termed *atrophies*, inasmuch as they also induce an abnormal mode of nutrition of the constituent elements of the tissue; but in these processes we observe a distinctive *factor*, in the *plus* of the transuded nutritive material in the exudation; but in their effects upon the tissue the two processes coincide. For instance, if we sup-

pose an exudation to take place in any part, the cell-life of that part, so far as concerns the nutrition, multiplication and motion of the cells, is at once placed under unfavorable circumstances, inasmuch as the nutritive fluid is required in an abnormal quantity. If in addition to this it also happen that a new formation of elementary organs is developed out of the latter, which also require a considerable amount of nutritive matter for their maintenance and multiplication, there thence arises again a new cause for the diversion of the nutritive material from the original, normal tissue; owing to which, both the tissue in which the infiltration had taken place, as well as that immediately surrounding the new formation, gradually wastes away. *Necrosis* is a common phenomenon in all tissues, the seat of inflammatory action, and takes place even in parts not the seat of infiltration, as they become gradually surrounded by the inflamed parts, and in this way have their connexion with the vessels conveying blood cut off.

Virchow has wholly discarded the notion of *atrophy*, and incorporated it with that of inflammation, which he terms a disturbance of nutrition, and which may occur under all known forms of disturbed nutrition, and is distinguished from simple degenerations only by the violence, rapidity, and amount of the change. He advocates, above all, the degenerative character of inflammation. We think that, in this, the idea of *inflammation* is taken in too wide an acceptation, inasmuch as all organs in a state of degeneration from advanced age, would necessarily have to be regarded as in an inflamed condition. In this case, the atrophy has a substantive existence, having nothing to do with any accompanying inflammation, if, as is usually admitted, the latter be described as an exudative process (increased transudation).

§ 1. Blood.

When blood has escaped from the vessels, in consequence of their rupture, or is retained within the organism for some time; or when, in large aneurismal sacs, enclosed, as it were, in a *diverticulum*, it is removed from the course of circulation for a lengthened period, an opportunity is afforded for observing changes in the red corpuscles. These morphological

observations are the most complicated in cases where the blood is enclosed within the living organism. Thus, we had an opportunity of examining the blood of a girl of 16, who had menstruated for the first time, and in whom Professor Chiari had been obliged to divide a duplicature of the mucous membrane of the *vagina*. The blood had been collected in the upper part of that canal for some weeks; it was tarry, viscous, and of a reddish-brown hue; when allowed to stand, no separation into *serum* and *crassamentum* took place; and when exposed in an open capsule to the air until dried up, it afforded no putrefactive odour. The red corpuscles were some of them shrunk, some ellipsoidal, and frequently presented two or three molecules disposed in the axis of the ellipse,—a metamorphosis of the blood-corpuscles, such as may often be produced artificially by the use of chromic acid. On being treated with water, they did not part with their colouring-matter, nor even did diluted acetic acid and carbonate of soda produce the same rapid decoloration as is caused by those re-agents in the red corpuscles of recent blood. Reddish-brown masses of very various dimensions were everywhere discernible, consisting in part of deformed red corpuscles, in part of little plates of the above colour, in which a nucleiform body might occasionally be perceived. Many larger plates exhibited a visible plication, and were, especially when tinged with a little colouring-matter, distinctly recognizable as large flattened epithelial cells from the *vagina*. The red blood-corpuscles (for instance, in the dark-coloured fluid of large ovarian cysts) swell, lose their acetabular depression, assume a dirty-yellow colour, and present a distinctly defined investing membrane,—a metamorphosis which may be artificially produced, by a dilute solution of iodine, in blood-corpuscles which have lost their colour on the addition of water. C. Bruch has remarked the alteration of form of these corpuscles in apoplectic cysts in the brain; and compares them with the form assumed by the blood-corpuscles after treatment with concentrated saline solutions, or when they are dried. According to R. Virchow, the cells contained in blood which has stagnated, within or without the vessels, differ from those which have been exposed to the action of water, in the circumstance that their membranes may be very readily seen without any further treatment, though always

very pale. The cells, at the same time, become smaller; and at the border, more rarely in the middle, may be perceived one, two, or three, extremely minute, sharply defined, dark-bordered, colourless granules, with transparent centres, which are sometimes isolated, sometimes form a series, being not unfrequently so connected together as to constitute a semicrescentic figure. We have had an opportunity of observing precisely such a change as this in the blood-corpuscles in the rusty coloured deposit in a cyst of the thyroid gland.

The white blood-corpuscles, without doubt, are usually sooner destroyed, although, under particular circumstances, they may be formed anew from the fluid protein-compounds of the blood, even within the vessels; a point which will be further discussed in speaking of pus-corpuscles.

The colouring-matter escapes from a great number of the red corpuscles, and is precipitated in the form of brownish-black particles (fig. 12, *a*, *b*), or may constitute the hematin-crystals, which have not yet been chemically investigated, or contribute to the colouring of *epithelium*, flocculent corpuscles, the intercellular substance, &c.; it may even be transformed into black pigment, the dark streaks formed by which indicate the remains of the dead blood.

Atrophy of the blood still in circulation, consists in the diminution of its elementary parts, and the increase of the fatty and aqueous contents. Precise quantitative determinations are still wanting on this subject, although the question, as to how far an increase of urea, of the saline contents, extractive matters, &c., in the blood, may contribute towards the involution of that fluid tissue, is, nevertheless, of the highest importance. The solution of this question must commence with the analysis of the blood in old age.

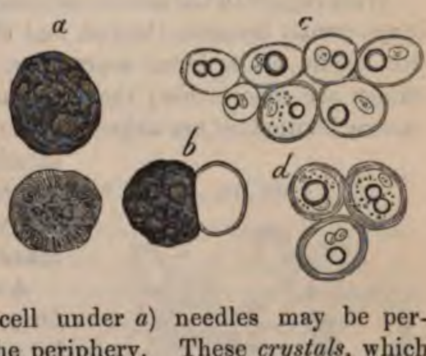
§ 2. Fatty and cellular Tissue.

Our attention is here directed principally to the fat-cells. For the proper study of the atrophic conditions of these elementary organs, it is necessary to examine single layers of them, taken by means of the scissors; for if several are superimposed one upon the other, the observation is much obstructed. Much emaciated, or dropsical, subjects should especially be selected.

Schwann was the first to notice the *nuclei* of the fat-cells, still very distinct in the subcutaneous cellular tissue of a rachitic child one year old. Kölliker has more precisely defined the morphological changes of the atrophied fat-cells, which he distinguishes into serous fat-cells; those deprived wholly of fat and filled merely with serum; and, lastly, those containing crystals.

In a morphological point of view we distinguish the following metamorphoses of atrophied fat-cells. In place of the ovoid figure which they possess in the normal state, and instead of their being so-filled with fluid, transparent fat, that not even a trace of a *nucleus* can be discerned, we notice a collapsing and flattening of the oval cell. The *olein* and *margarin*, either remain enclosed in it, and become decomposed, or are replaced by a serous fluid by endosmosis, in consequence of which the remaining fluid fat is suspended in the serum, and ultimately, gradually disappears altogether from the cell. In the former case we remark granular *dark brownish yellow contents* (fig. 14, *a*); the cell appears more or less tuberculated, and the contour line has lost its oval form owing to the numerous sinuosities. When treated with carbonate of soda, the coloured substance is not removed, even after a prolonged action, nor, owing to the dark colour, is it possible to discern groups of crystals in it. In similar cells, however, of lighter hue (*vid.* the cell under *a*) needles may be perceived radiating towards the periphery. These *crystals*, which are more probably *margaric acid* than *margarin*, also appear in stellate groups (*vid. lipoma*). The colour cannot well be attributed merely to the accumulation of crystals, but must be due to the metamorphosis of the colouring matter proper to the fat as such. It is highly interesting to observe that (fig. 14, *b*) a coloured fat-cell contained a granular substance, and, consequently, in a state of atrophy may occur in connexion with one in perfectly normal condition. This circum-

FIG. 14.



stance affords a striking proof of the independence of the cells, in their involution.

The second case, in which the fluid fat is either partially or wholly replaced by a *serous fluid*, is manifested by a flattening, owing to the circumstance that the fat no longer distends the cell wall, but appears in the form of spherical, sharply defined, strongly refractive globules, of a light or deep yellow colour verging into a yellowish red (fig. 14, *c*, the sharply defined circles within the cells). The cell membrane retains its rounded figure, and often presents a double contour line. The most important circumstance, however, is the appearance of the oval, pale-coloured *nucleus* furnished with a *nucleolus* (fig. 14, *c*, the delicate, oval bodies contained in the cells). The *nucleus* is sometimes single, sometimes double, and it is brought into view more distinctly on the application of acetic acid. It is at once obvious that the *nucleus* is not formed merely after the disappearance of the fat, but that its existence in the normal fat cell must be supposed. The fat-globules in this form of atrophied cell may ultimately disappear altogether, a finely granular material often presenting itself instead.

With regard to the cell-membrane, it is to be remarked that it apparently becomes thicker, and that several *concentric layers* are visible on its inner aspect (fig. 14, *d*). In this case two things are conceivable; the apparent thickening, and the concentric lamination, are either caused simply by a folding of the cell membrane, or, if that be denied, we are compelled to assume a deposition of solid layers on the inner surface of the membrane.

Fig. 15.

A somewhat different atrophic form is presented when the fat is subdivided into a multitude of globules (fig. 15, *a a*), which are frequently grouped around a lighter coloured, ill defined space (serum). In many of these cases the cell membranes are no longer visible, and the cells are also placed at certain distances apart. No ves-

tige of the *nucleus* can be perceived. These forms were occasionally met with in an œdematous mesentery, which had become swollen into a gelatinous, watery pulp; and in the case, from which the figure was taken, in the tunic of a gelatinous *sarcoma* seated in the subcutaneous cellular tissue. For the purpose of comparison, the normal fat-cells which occurred in association with the above, have been added (fig. 15, *b*), and, to complete the picture, the elastic filaments with their enlargements and divisions (*c*, *c*), and jagged margin, have also been given.

Kölliker describes other metamorphoses of the fat-cells besides those above noticed, such as cells sometimes rounded, sometimes fusiform or stellate, and furnished with 3-5 irregular processes often of some length, which are said to be developed out of adipose cells deprived of their oily contents. We cannot coincide in this opinion, because, in the first place, the metamorphosed cells so described and figured, differ in no respect from young cells of connective tissue; secondly, because, according to our experience in pathological histology, no instance exists of a pathologically modified cell which has assumed entirely the habit of another kind of cell, either normal or newly-formed, or, as in the present case, of an entire series of them; and, thirdly, because it is not a rare occurrence for new formations of cellular tissue to take place together with serous collections; with respect to which we would simply indicate the case of cysts.

The fat, which is removed from the adipose cells in cases of emaciation, must enter the intercellular fluid, whence it is taken up by the lymphatics; the collapsed groups of fat-cells are reduced to a smaller volume, until their contents are by degrees entirely removed, nothing but the delicate cell-membrane remaining, which, in many cases, undoubtedly undergoes a complete solution. Not long since we were enabled to trace, for a considerable distance, a large number of lymphatics in an œdematous adipose tissue (in the muscular tissue), whose character was placed beyond doubt by their course, their saccular sinuosities, and finely molecular contents. The fat-cells presented the characters proper to them in a state of atrophy. We do not conceive that these vessels were of new-formation, because they were also met with in the normal adipose tissue,

and were only more manifest than usual in consequence of the œdematous condition of the part.

In the *cellular* (connective) tissue, we distinguish the phenomena of atrophy into those occurring in the areolar framework, and those whose seat is in the *areolæ* (in the elementary organs contained in them) and in the intercellular fluid. In the *areolæ* the retrograde nutrition is indicated by deposits of various kinds, among which we would place *fat* in the first place. This material is usually deposited in the form of larger or smaller fat-globules, which are unaffected by acetic acid, are rendered more distinct by alkalies, and when expressed, float on the surface of the fluid in oily drops. They occur not only in the inter-cellular fluid but also, as a form of degeneration, in the elementary organs, which (young connective tissue-cells of rounded or fusiform shape) present an accumulation of fat-globules in their contents. *Cholesterin*, in the form of minute, superimposed, transparent plates with jagged edges, is frequently met with in the *areolæ* of atrophied connective tissue, especially in old persons. *Pigment* occurs as an orange-yellow, reddish-brown, brownish-yellow, brownish-red, and black, granular, aggregated deposit. Of the inorganic salts, the principal here met with belong to the calcareous group—carbonate and phosphate of lime—they assume the form of amorphous masses, sometimes granular, sometimes nodular, which dissolve in acetic and hydrochloric acids, sometimes with, sometimes without, the evolution of air bubbles. A very frequent form is the collection of a hydropic (serous) fluid, by which the *areolæ* and areolar passages are distended, and the cells subjected to a gradual fusion. The thin fluid, at the same time, owing to the communications between the *areolæ* is easily forced from one into another by pressure or the dependent position, an experiment which may be easily performed, especially in an œdematous extremity.

The areolar framework, undergoes essentially the same morphological changes, inasmuch as similar deposits take place between the separate fibres and bundles of which it is composed. The blood-vessels, running in the framework, collapse, together with the latter, and the volume of the connective tissue is diminished, since, according to the notion of the older physiologists, the exhalation (*halitus vitalis*) of a gaseous fluid from

the blood ceases, and in this way the so-termed *turgor vitalis* subsides.

§ 3. Cartilaginous tissue.

This tissue is especially adapted for the study of atrophied tissues, since fine sections in various directions may be readily prepared from it; the textural changes are very manifest and easily traced.

The contents of the cartilage-cells are metamorphosed. They frequently contain unusually large fat-globules, (fig. 16, the strongly defined, light coloured, circular and oval bodies in the cells), which often occupy the entire cell, in consequence of which, the granular *nucleus* of the latter gradually disappears. It cannot be denied that distinct fat-globules occur in cartilage which, to the naked eye, presents a perfectly normal aspect, and in which the cells thus containing oil cannot properly be described as in a state of atrophy, unless at the same time some change in the intercellular substance has previously taken place. An accumulation of *pigmentary molecules*, usually of a brownish-yellow hue, begins to take place around the *nucleus* far more probably than in the *nucleus*, and gradually extends throughout the cavity of the cell, so that ultimately the entire cell is filled with it, a sharply defined fat-globule being at the sametime included in it (fig. 16, *a*). According to our present experience, the *nucleus* in the atrophied cartilage-cell undergoes no determinate pathological change, it simply disappears, as stated above.

Fig. 16.

An apparent thickening of the cell-wall, similar to the one above described, as occurring in atrophied fat-cells, may be witnessed in many cartilage-cells, the appearance in this case also admitting of a different interpretation. But here the circumstance is superadded that a cartilage-cell with thickened walls might represent one in what is termed the process of ossification. The membrane, especially of the secondary cells,

not unfrequently undergoes a sort of solution, nothing remaining but a parent-cell with several fat-globules.

With respect to the *intercellular substance,* several metamorphoses are to be noticed. The normally structureless, transparent substance between the cells (fig. 16) becomes granular, and a *brownish-yellow molecular material* accumulates in thicker or thinner layers around the individual cells, so that the latter are partially or entirely concealed, nothing but the fat-globules being apparent (fig. 17, the dark intercellular substance *c*). In consequence of this, the cartilage loses its opaline aspect and its proper transparency in thin sections; it becomes yellowish, brownish-yellow, even to the naked eye, and loses much of its elasticity. When sections of cartilage in this condition are treated with alkalies, no appearance of change will be perceived either in the coloured cells or in the coloured inter-cellular substance, any more than is noticed after the application of acetic acid. A deposition of *fat* assuming the form of scattered largish fat-globules, like those in the cells, is never observable, whilst smaller fat-drops perhaps make their appearance, which become grouped into granular masses.

Fig. 17.

The metamorphosis of the structureless intercellular substance, for instance, of the articular cartilages, into a ligamentous or fibrous texture, is one of considerable interest. Cartilages in this condition are of a dirty yellow colour, brownish-yellow, and occasionally present a homogeneous aspect; they are much more lax in their consistence, and so soft that they can be said rather to be scraped than cut by the knife. The intercellular substance (fig. 18, *a*) is split into fibrils, sometimes very delicate and undulating, and sometimes

Fig. 18.

of more considerable size. They decussate frequently and in various directions, often projecting at the border of the preparation as ligamentous threads. They enclose the cartilage-cells more or less infiltrated with fat, which in the case above noticed (investing cartilage of the osteoporous upper extremity of the *tibia*) were beset with several brilliant molecules, and furnished with oval *nuclei*. The latter, as well as the molecules, were rendered more manifest by the action of acetic acid, whilst the fibrous substance disappeared. In a fibrous intercellular substance of this kind, Dr. Redfern noticed a series of elongated *nuclei*, brought into view by acetic acid, whose longer diameter corresponded with the direction of the fibres.

The intervertebral cartilages of aged individuals are usually of a dusky colour, and dry; and the fibrous intercellular substance contains pigment. The intervertebral cartilages of an imbecile woman, more than 70 years old, afflicted with *cyphosis*, were atrophied to an extreme degree, of a dirty brown colour, and contained *crumbly calcareous masses*, without a trace of osseous texture. Some of the cartilage-cells, concealed in the opaque intercellular substance, were liberated in the dissection, and presented a brownish-yellow colour. The calcareous particles were deposited in considerable quantity in the centre of the cartilage.

The retrograde formations of cartilage, above enumerated, are induced by disturbances of the circulation in those vessels by which the nutritive fluid is conveyed to the affected tissue, and the cartilages, according to the diversities of their structure in various parts of the body, and the special morbid process affecting their nutrition, necessarily undergo different modifications of retrograde formation. Exudations in the mucous membrane and submucous tissue of the air-passages as in *tuberculosis*, chronic catarrh, reiterated pneumonia, &c., will injuriously affect, from the inner side, the nutrition of the cartilage, whilst towards the *perichondrium*, on the outer aspect (fig. 17, the right border, *b*), the nutrition is less interfered with, the circulation in the nutritive vessels in the *perichondrium* suffering no interruption.

The proposition broached above, that hypertrophy of one portion of tissue may frequently be noticed conjoined with

atrophy of another, receives confirmation in the present instance also. The nutrition of a group of cartilage-cells may cease, in consequence of the deposition of fat, or the precipitation of molecular, pigmentary matter, in their contents; and their multiplication will also cease, owing to the cessation of the nutrition, whilst, in a contiguous group of cells, conditions of precisely an opposite nature will be observed; an increased supply of nutritive fluid being afforded to the latter, in consequence of which, a more active production of cells will take place. It very frequently happens, also, that a considerable quantity of cartilage-cells may be observed crowded into the same space; which is due, in part, to the increased volume of the cells, which may amount to more than double the usual bulk, so that the intercellular substance is supplanted to a greater or less extent.

Let us consider, for instance, the conditions presented in the cystic thyroid gland, in which, owing to the partial increase in the bulk of, and special new-formations in the gland, the vessels of the *perichondrium* of the *larynx* are also involved in the disturbance of the circulation; and the nutritive conditions of the subjacent cartilaginous tissue are so altered, that an anomalous state of the texture is obvious, even to the naked eye. The cartilages become dry, yellow, dirty brownish-yellow, and occasionally softened, so as frequently to present a soft, pulpy consistence, especially towards the middle of their transverse diameter. If the softened part be examined microscopically, it will exhibit the appearance shown in fig. 19. Some of the cells are seen to contain oil-globules, the granular *nucleus* is still visible in most of them; the walls in many are thickened (a); the intercellular substance enclosing, sometimes a finely granular material, grouped especially around the cells, sometimes elongated corpuscles (b b), which can scarcely be regarded in any way as *nuclei*, inasmuch as they correspond, both in their refractive power and in their chemical properties, with fat-

Fig. 19.

globules. In the very soft parts, lastly, nothing remains but a grumous material, where the cartilaginous substance has become almost entirely broken up, and an amorphous matter, sometimes containing pigment, sometimes fatty, with scattered calcareous particles, constitutes the principal element.

If the drier, brownish-yellow portions of the laryngeal cartilages in this state of atrophy be selected for examination, we shall observe the appearances represented in fig. 20, exhibiting a group of the various kinds of pathological, morphological metamorphoses of the cells. They cannot all, however, be described under the term *atrophy*. It has already been stated, that cartilage-cells, with apparently thickened walls (fig. 20 *a, c*), may also be noticed at the commencement of the process of ossification. Thus, the cells *b b* represent imperfect forms of development into secondary cells; and, in the same way, between *b b*, and near *c*, may be observed a granular mass, which must, perhaps, be explained as of new formation, and not as resulting from the retrograde metamorphosis of a cartilage-cell. In the parent-cell, *d*, will be noticed an accumulation of a coloured granular material, particularly towards one side, the secondary cells containing fat-globules of considerable size. The other cells are in a state of fatty and pigmented degeneration.

FIG. 20.

In what is termed by Albers *perichondritis laryngea,* when the exudation passes into a puriform new-formation, a suppurating sac of various dimensions, as Dittrich has correctly described it, is developed, most usually formed of a thick, whitish-grey, or slate-coloured fibrous tissue, which appears sometimes to be wholly of new-formation, sometimes to be intimately coalescent with the surrounding textures. Within this capsule is contained a thick, purulent, or ichorous, fluid. In that situation, not a vestige of the *perichondrium* is any longer to be discerned; the affected cartilage is bathed by *pus* and *ichor*, sometimes throughout its whole extent, sometimes in a circumscribed

space, and often floats about in a detached state in the fluid. It is manifest that, in this case also, the cessation of nutrition, and the death or necrosis of the affected cartilaginous tissue, are consequent upon the development of pus-corpuscles in the *perichondrium*.

A process of a precisely analogous kind takes place in *caries* of the bones towards the investing articular cartilage, which is raised, as it were, by the suppuration proceeding from the bone. This separation of the articular cartilage is manifested, especially at its borders, which are gradually detached; and by means of the forceps, larger or smaller fragments, or even the entire cartilage may be elevated, to which a thin layer of bone remains attached. The substance of the cartilage appears somewhat softened, and its transparency is diminished by the considerable quantity of fat which may be shown to exist in the cells; and the light, blueish-grey colour of the surface is replaced by a yellowish tinge.

A new-formation of pus-corpuscles around the vessels by which the nutrition of the cartilage is carried on, is equally conducive to the atrophy of the latter; thus, also, the new-formations of connective tissue which frequently occur simultaneously with that of *pus* in the *cancelli* of the articular ends of the bones, and even appear in the form of substantive *neophytes*, are greatly conducive to the retrograde development of the articular cartilage. *Sarcoma* and *cancer*, when seated in the bones near the articular cartilage, will induce the atrophy of the latter. The growths and suppurations of connective tissue, which are of such frequent occurrence, may cause a solution of the osseous tissue in circumscribed portions, whence irregular, ulcer-like losses of substance arise.

§ 4. Osseous tissue.

Atrophy of the bones depends upon a partial or complete abolition of nutrition throughout the bone, or in separate portions. It is in general induced by the involution of those tissues by the aid of which the nutrition is carried on. The various kinds of the latter are also followed by various forms of atrophy in the bone. We have, therefore, to consider (1): the retrograde development of the tissues subservient to the

nutrition of the bone, and to discuss the causes by which this is induced; and (2): thence to develope the divers forms of atrophy of the bone, considered organically.

The forms of retrograde development of the tissues subservient to the nutrition of the bone, have reference, in the first place, to the *medullary substance* and the *periosteum*. The fat-cells of the former have been described by Hasse (in rheumatism), and by Kölliker (in the hyperæmiated *medulla* of the articular ends of bones), as containing *serum*, and as being deficient in fatty matter; and they resemble the forms figured above (fig. 14 *c*, and fig. 15 *aa*). But there are also those dark brownish-yellow metamorphoses of the fat-cells represented in fig. 14 *a*. The *vessels* of the *medulla*, under these circumstances, may be either *anæmic* or *hyperæmic*; in the latter case, owing to the interruption of the circulation, they will convey no fresh supply of blood, and the *stagnant blood* acts directly as an impediment to nutrition. This stagnant blood, whether included in the vessels or partially extravasated, now undergoes those retrograde metamorphoses of which we have spoken more particularly in referring to the atrophy of that fluid. In this way is produced the dirty, dark red, greasy *medulla*. In the anæmic condition of the vessels of the *medulla*, their walls collapse, and the elementary organs of which they are composed gradually shrink, nothing being left, for the most part, but the accompanying connective-tissue fibres, which are beset with a brownish-yellow pigment. As a form of atrophy occurring in the *medulla*, we must describe that in which *calcareous granules* are found in the *cancelli*; it is met with especially in old individuals, and is due to the deposition of amorphous, calcareous salts, no longer capable of entering into an organic union with the osseous tissue.

The *periosteum*, composed of connective tissue with vessels ramifying in it, communicating with those proceeding to the surface of the bone from the medullary canal, exhibits its atrophied condition by its shrinking, or by the softening of its substance, together with the loss of its silvery lustre and the diminution of its cohesion to the bone.

If we inquire into the *causal* influences that induce the above-described forms of retrograde development of the tissues subservient to the nutrition of the bone, we shall find that they

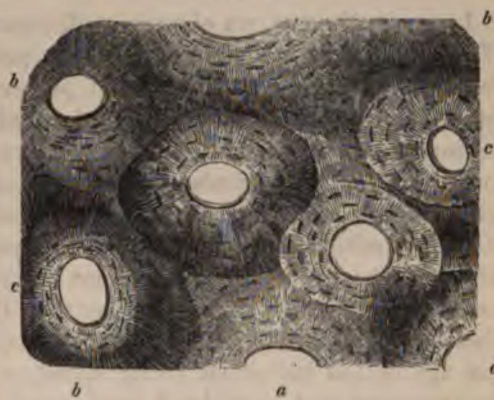
may be subdivided into *general* and *special*. The former are to be sought in the general disturbances of nutrition and motion. In old age an atrophic condition of the blood, as the general nutritive fluid, is established, and induces the form described as *senile atrophy of the bones*. This insufficiently nutritive condition of the blood, however, occurs not only at the normal period of involution in old age, but also in those premature atrophic states of the blood which accompany *tuberculosis, syphilis,* gout, rickets, &c. These diseases, consequently, are often attended with atrophy of the osseous tissue, though undoubtedly of a modified kind. General disturbances of the motile faculty, such, for instance, as occur in paralysis, secondarily induce a retardation of the circulation, in consequence of the diminished contractility of the motile organs; which retardation, in the paralysed parts, may lead to atrophy of the bone.

The *special* causal influences consist in local, pathological formations, injuriously affecting the nutrition of the bone in a circumscribed extent, or which may entirely cut it off; formations of this kind are aneurisms, abscesses, sarcomatous tumours, osteophytes, &c. (*vid.* new formations of the osseous tissue). The various forms of *osseous atrophy* developed from causes of this kind, concern the *bone-corpuscles* and the *intercorpuscular substance*. With respect to their external aspect, the former undergo no further metamorphosis, the contents alone are subject to various modifications, for the bone-corpuscles often appear throughout of a dark, black colour, which cannot be ascribed merely to the air contained in them, since the dark hue cannot, like that dependent upon the presence of air, be removed by careful expression in Canada balsam. The remarkably light colour of the bone corpuscles, recalling their appearance in young, developing bones, occurs principally in bones undergoing absorption. The *intercorpuscular* substance in necrosed portions of bone frequently presents a dark, brownish-yellow colour (fig. 21). A portion of the *tibia* whose nutrition had been cut off by an exudation (necrotic) has been selected for representation; and in the transverse section of which the speckled aspect of the bone is very well shown.

At *a a*, are seen Haversian canals, laid open perpendicularly to their long axis, around which the elongated, opaque bone-

corpuscles are disposed in concentric layers. The radiating *striæ* in the lighter parts (*c c*) correspond to the radiating bone-canaliculi. The dark spots (*b b b*) were observed principally at the points of contact of the systems of bone-corpuscles disposed around the Haversian canals, and in some places were so deeply coloured as entirely to conceal the bone-corpuscles. This is a metamorphosis of the tissue in all respects analogous to the dark colouring of the intercellular substance of cartilage (figs. 16 and 17). Now the question whether this dark coloration is to be regarded as produced by the deposition of the colouring matter of the exudation, or merely as a product of conversion from the peripheral towards the central layers, in our opinion should be decided in favour of the latter supposition, inasmuch as colorations of this kind in bones, especially in old people, occur without any accompanying exudation.

FIG. 21.



Another morphological change of the intercorpuscular substance consists in its *cleavage*; it is characterised by a more distinct appearance of the lamellar structure, and occurs, for instance, in *osteomalacia* (*vid. sup.* on exudations).

A *fatty degeneration* of the bone, that is to say, an accumulation of free, fluid fat not enclosed in cells, is manifested by a yellowish colour, greasy feel, the transudation of oil, in spite of repeated boiling, a diminution in the transparency of thin plates, and by a greasy, liquefied *medulla*. Under these circumstances, the fat penetrates the porous osseous substance from the medullary canals and *cancelli*, and by the deposition of its colouring-matter, may produce a partial discoloration of the bone. This condition of the bone, consequently, must also

be regarded as a form of involution. It is met with especially in old persons, affected with apoplexy or cancer.

§ 5. Muscular Tissue.

In many diseases, we observe a diminution of the muscles. When the transverse diameter of the primitive *fasciculi*, in these cases, is compared with that proper to them in a given region, and at a given age of the individual, a manifest diminution will be noticed. The number of primitive fibres constituting the *fasciculus*, must consequently have been reduced. Calculations respecting the diminution in number of the primitive *fasciculi* have not as yet been undertaken, although they may be carried out approximatively without much difficulty. In the same way that the mean transverse diameter of the normal primitive *fasciculi*, the particular muscle and age of the individual being stated, may be estimated in the transverse section of dried portions of the muscle, and the number of transversely divided primitive *fasciculi* may be counted in a given superficial space (for instance, one-tenth of a square line), regard being paid to the number of times the superficial space taken is contained in the transverse diameter of the whole dried muscle,—so also may the same estimation be made in atrophied muscles. It is self-evident, that the transverse section of the muscle should be made at a determinate point,—for instance, the middle of the belly of the muscle,—the number of primitive bundles diminishing towards its origin and insertion.

In atrophy of the transversely striped muscles, the primitive fibrils must undergo absorption.

Muscles placed under circumstances of insufficient nutrition, lose their bright, flesh-red colour, and assume a brownish tinge. Upon more minute examination, it is apparent that numerous, elongated groups of dirty-yellow *pigment molecules* are deposited in certain interstices of the *sarcolemma* (*vid. sup.* hypertrophy of muscle). This accumulation of pigment also takes place in the interstitial connective tissue.

The diminished cohesion of the atrophied muscle is shown in the ease with which it admits of being *lacerated*. Care must be taken not to confound this pathological condition with the easy lacerability artificially produced by putrefaction,

or maceration. In the pathologically diminished cohesion, the *fasciculi* are more readily subdivided into the primitive fibrils (fig. 22). The more lax *sarcolemma* is readily lacerated, and primitive *fasciculi* torn across, are met with (*a*). The primitive fibrils, when a minute portion of muscle is teased out, are readily isolated (*b*), but, nevertheless, present their proper transverse markings. This example was taken from the *gastrocnemius* of an aged individual affected with cancer in several organs, and the muscle had undergone a partial fatty degeneration.

FIG. 22.

Fatty degeneration is a form of retrograde development in the transversely striped muscles, in which their peculiar character, viz., the transverse striation, is lost, and an accumulation of highly refractive, brilliant, sharply defined globules is apparent within the *sarcolemma*. These globules (fig. 23) in many of the primitive *fasciculi* are more scattered, and fewer in number, whilst in others they are so densely crowded together that the *fasciculi* present the appearance of opaque streaks, upon which larger oil-globules are occasionally observed. The globules remain unaltered in acetic acid, and in dilute alkaline solutions. Virchow has remarked, that in many primitive *fasciculi* the oil-drops are disposed in very fine and delicate moniliform series one behind the other, and occupying the longitudinal axis of the *fasciculus*, appearing to correspond exactly with the longitudinal fibrils of the muscle. In this circumstance he sees a confirmation of the universality of the law which governs the fatty metamorphosis in the nitrogenous primitive elements of the body.

FIG. 23.

From this accumulation of fat in a state of minute division not only in the primitive muscular *fasciculi*, but also in their interstices, the portion of muscle so affected acquires a dirty, yellowish hue. This discoloration usually appears in an irregular, radiating form in distinct portions of the muscle (heart, *gastroc-*

nemius), more rarely extending over the whole of it. In the highest degree of fatty degeneration, according to Rokitansky's observations, the form of the muscle is ultimately lost, and in a limb whose muscles are so affected, nothing may remain but the tendons, and aponeurotic membranes and processes.

The forms of atrophy now under consideration are mainly induced by causal influences, which, as they relate to the general process of nutrition, may be called *general*. They occur in many diseases, both acute and chronic, as *tuberculosis, cancer, typhus, &c.*

There are also causes which produce merely a *local atrophy* in the muscles. Such are the agencies by which the supply of blood is partially or entirely arrested in a muscle or set of muscles, and this may be effected in various ways: 1. In consequence of paralysis of the nerves through which the contractions of the muscles are excited. Owing to the inactivity of the latter, the circulation in the parts affected is deprived of its necessary support, and a retardation of the current of the blood must ensue. 2. In consequence of partial hypertrophy of a muscle, for instance, of the heart. In the course of the work we shall show more particularly that true, pathological hypertrophy occurs only partially, and is very frequently combined with a manifest atrophy of the contiguous tissues of the same kind. On this account, in an atrophied heart, we frequently notice portions of the muscle in a state of involution, that is to say of fatty degeneration. 3. A local muscular atrophy may be induced in two ways by aneurisms; firstly, when in consequence of a more considerable extension of the swelling, the nutrition of the muscles surrounding the aneurism is diminished by the pressure; and, secondly, because the retardation of the circulation which takes place externally to the dilated artery must induce an atrophy of all the tissues implicated, and among these, of the muscles. 4. An atrophy of the muscles is induced by serous exudations, partly from the mechanical pressure upon the surrounding substance, partly in consequence of the muscle being deprived of some of its nutritive material. Among these new formations the most interesting are those composed of connective tissue, and seated in the interstitial tissue of the muscles, owing

to which the muscular substance is gradually replaced by a fibrous tissue, and a membraniform aspect of the muscle produced. This change is conjoined with a shortening of the original length of the muscle, which should not be ascribed to contraction, it might be described as *atrophy of the muscle produced by the growth of connective-tissue*, and is one of the highest importance, especially in a surgical point of view, inasmuch as it is productive of the greatest variety of deformities. It may be localized in individual muscles or parts of muscles, and is, secondarily, the cause of displacement in the bones to which the muscles are attached. In this way arise the affections termed "wry-neck," club-foot, curvatures of the spine, &c., which have been erroneously classed under contractions, a view necessarily requiring the hypothesis of the existence of a continued muscular contraction.

The elements of the *organic muscular fibres*, undergo chiefly a fatty degeneration of their contents; but at the same time much fat occurs in the interstitial tissue. This kind of involution is seen most strikingly in the intestinal canal and urinary bladder; in the latter case usually combined with hypertrophy of the muscular coat. Wasting of the organic muscular fibres is observed as a consequence of old age, and of diseases attended with emaciation.

§ 6. Vessels.

We shall commence with the capillaries, as the conditions are more clearly displayed in them and the smaller arterial vessels.

In this case, also, may be noticed the deposition of fatty molecules, which must be regarded as *a fatty degeneration of the elementary organs of the vessels*. In minute vessels (fig. 24) taken from the brain of an old person dead of apoplexy, and of which the drawing was made after treatment with acetic acid, there will be perceived around the situation of the *nuclei*, groups of molecules, which, as may be clearly seen in all three vessels, are not elevated above the surface, but are manifestly imbedded in the substance of the wall. In (fig. 24, *a*) are represented two branches of a capillary, arising from a single trunk, in which a variation

as respects the position of the oval *nuclei* begins to be apparent.

Fig. 24.

For the latter are placed in the capillaries, with their long diameter parallel to the course of the vessel, whilst in the trunk, *nuclei* placed transversely may still be seen. The brilliant molecules are arranged partly in a longitudinal direction, sometimes, in the smaller trunks, assembled in groups (*b*). The vessels *a* and *b* consist of fibre-cells, to which belong the oval *nuclei*, grouped in a spiral form; but the walls of these cells are so intimately coalescent as to be inapparent. Just as we have already shown, with respect to several elementary organs, that the fatty degeneration of their contents is a form of involution, and shall have to show the same thing in other cases, so in that of the capillaries, we are compelled to describe these groups of fat molecules as a fatty degeneration of the contents of the fibre-cells, and consequently must consider the expression *angioitis capillaris*, as inapplicable. In fig. 24, *c*, is shown a minute artery, containing, in its various layers, partly longitudinal rows, (in the outer cellular-tissue layers), partly irregular smaller and larger groups of these brilliant molecules.

It should here be remarked that this form of involution of the small vessels must not be confounded with those pathological conditions where new-formed masses of granules are deposited on the outer wall of the vessel (fig. 64, vessels with masses of granules upon them, in *encephalitis*), or in which minute aggregations of granules adhere to the vessel (*vid.* Malpighian corpuscles in the commencement of Bright's disease, fig. 56).

Vessels in this state of involution are most readily procured for microscopic examination from the brains of apoplectic individuals, and may be readily drawn out by the forceps in the neighbourhood of the apoplectic effusion; or small portions of the brain being well washed for the removal of the blood, and carefully torn up by means of two needles, the delicate vessels

may be seen hanging from the border of the preparation. Their dissection is more troublesome in the denser parenchymatous organs, as, for instance, in the atrophied kidney.

It can scarcely, perhaps, be doubted that this degeneration of the walls of the vessels bears a causal relation to the subsequent hemorrhage, as has been shown by Kölliker to be the case in the degenerated minute cerebral vessels in apoplexy. The elasticity of the capillaries and minute arteries, as well as the contractility of the latter, is diminished, and a rupture, consequently, of these vessels, when the impulse of the blood is augmented or its return impeded, will the more readily take place.[1]

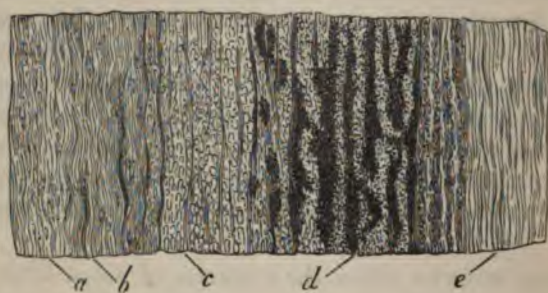
The capillaries and minute arteries and veins possess, as is well known, no nutritive vessels, but are nourished by the blood circulating in them; if the circulation, therefore, be interrupted, the stagnant blood undergoes those morphological changes which we have described under the head of atrophy of the blood; but should the vessel be empty, as takes place in many situations, in consequence of the very frequent extravasations of blood which occur in exudative processes, its walls will collapse, and in either case the vessels will waste so much that the elementary tissues of which they are constituted will be rendered wholly unrecognizable; the existence of the vessels in the atrophied tissue being indicated merely by bifurcating or looped, broader or narrower streaks containing black pigment.

In *larger arteries* (from the diameter of about 0·88‴ up to that of the *aorta*) other nutritive conditions are superadded, a proper system of vessels ramifying in the connective tissue-coat, long known under the name of *vasa vasorum*, and which, according to expert anatomists, is said to extend into the annular fibrous tunic. We say *additional* nutritive conditions, deeming it impossible to deny that the innermost parts of the large vessels are nourished by the blood circulating in them, in the same way that the entire walls of the smaller vessels are nourished. We are compelled, therefore, to ascribe the fatty degeneration of the thicker walls of the vessels to insufficient nutrition, sometimes from without, sometimes from within.

[1] *Vide* also Paget, on Fatty Degeneration of the small Blood-vessels of the Brain, and its relation to Apoplexy. ('Med. Gazette,' 1849.)

In the examination of the incipient atheromatous deposits in the popliteal artery of a woman 60 years old, we noticed, in a transverse section, that the deposit was on the outer side of the annular fibrous coat, *a* in fig. 25 corresponding to the innermost layer, in which some of the longitudinal fibres only are divided at right angles; the vacuities there visible belong to the minute interstices of the fibrous network. At (*b*) may be perceived traces of wavy fibres, bearing the closest resemblance to those of connective tissue. In the normal condition there also occur, not only in these situations, but in the whole thickness of the annular fibrous coat, scattered indications of bundles of connective tissue between the layers of elastic filamentary networks and the thicker, solitary, tendril-like, elastic filaments; *b*, as well as *c*, correspond to the annular fibrous layer, only in *c*, the transverse oblique sections of the reticulated fibres are distinctly visible. In the outer layer of the annular-

Fig. 25.



fibrous coat, a fine granular material is apparent, deposited in concentric layers, and diminishing towards the exterior or towards the connective tissue-coat *e*, where it wholly ceases. From its reaction, this material proved to be *olein* in a state of minute division.

In this case gangrene had taken place in both feet. The crural, popliteal, tibial, and peroneal arteries, as well as the corresponding veins in both limbs were filled with blood-clots. The *coagula* were consistent, partly of a reddish-brown colour, partly speckled with a dirty yellow; when compressed they afforded a greyish red, pulpy matter, consisting of numerous, irregularly oval *nuclei*, similar to those which are constantly

met with in the spleen, lymphatics, &c., together with flocculent molecules. There were also minute, pale, discoid corpuscles corresponding in size with those of the blood, and presenting within their margins, dark, adherent molecules in a single or multiple row; these were first described and figured by Virchow as blood-corpuscles deprived of their colouring matter and containing dark granules. Rather pale blood-corpuscles, with the characteristic central depression, occurred only in small quantity. The coagulated *fibrin*, when torn asunder, exhibited fibres which could be traced only to a short distance. Brownish-yellow pigment, in the form of aggregated granules, was scattered throughout. *Coagula* were also found in the jugular veins; in the right *corpus striatum* there was a large encephalitic deposit, the central part of which was broken up into a sanious, turbid fluid. The mitral valve of the heart was imperfect, and there were fibrinous deposits in the spleen and kidneys; those in the former situation presented a pultaceous matter, containing, together with abundant orange-yellow, granular pigment, delicate acicular groups of crystals in considerable numbers, which were not further determined. In the kidneys, the pyramids in some parts, and in others the cortical substance, were infiltrated with dirty yellow, fibrinous masses, speckled with reddish-brown, and forming circumscribed patches.

The principal questions which present themselves in this case are the following: is the molecular matter, *d*, to be regarded as an exudation, or as representing an imperfect nutritive material; is an exudative process or insufficient nutrition the cause of its production? Considering that this accumulation of fat in a state of minute division is, in all respects, analogous to that which we have described as existing in the elementary tissues of the capillaries and minute arteries, and that every anatomical consideration in this and several analogous cases is opposed to the supposition of an inflammation in the connective tissue-sheath (since, in the moist state of the latter, no vascular injection whatever existed), we consider ourselves justified in describing this accumulation of fat as a form of involution, arising from imperfect nutrition on the part of the *vasa vasorum*.

The possibility that the substance, *d*, in the case just cited,

was a sort of deposit from the blood-coagulum, is at once disproved, when it is considered that deposits of that kind without any coagulation are very frequently met with in the arterial vessels of aged individuals.

The mode of preparation to be adopted, depends upon the circumstance, whether we are desirous of examining the layer of the vessel in transverse sections, or in portions which have been removed horizontally. Fine transverse sections require the arteries to be dried in the expanded condition. In the larger vessels it is advisable to immerse them in a dilute solution of corrosive sublimate, of acetic or pyroligneous acid, for otherwise putrefac- may take place during the prolonged desiccation. Sections, perpendicular to, and parallel with, the longitudinal axis of the vessel may be readily made through the dried coats, but it is advantageous slightly to moisten the surface from which the section is made, in order to obviate the too great brittleness. To some extent the layers may be raised by means of fine forceps, from the coats of the artery, when extended; in which way, it is self-evident that the observer must proceed to work in a determinate manner. In this way also, it may be proved, that in the clouded and somewhat thickened portions of the arterial tunics, which by reflected light present a dirty yellow colour, the deposit of *olein*, in the form of larger and smaller molecules, diminishes towards the outer layers of the annular fibrous coat, and ceases towards the cellular.

This atrophic condition *must not be confounded with arteritis*, of which we shall treat in speaking of the family group of exudations; and the former, in many cases, very probably stands in a causal relation with the latter. It is certain that the elasticity and contractility in the larger vessels also, is affected by the accumulation of fat, and, consequently, that when the impulse of the blood is increased, or its return impeded, a dilatation will occur in the parts more fully infiltrated with fat. At the same time, it is rendered impossible that the subsequent contraction should restore the vessel to its pristine calibre. The tension of the cellular coat consequent upon the dilatation, will again be productive of secondary disturbances of the circulation in it. The dilatation, however, may also be primary, and induced by the anatomical change in the coats of the vessel, as Virchow has shown to be the case

in the development of the collateral circulation, after partial interruption to the current of blood. We were satisfied of the primary dilatation of minute arteries in the submucous cellular tissue in the intestine of a Horse, with a visible thinning of the walls.

By the collapse of the walls, the arteries become transformed into ligamentous cords, in which, occasionally, a slender canal may still be observed, filled with a dirty yellow, reddish-brown, or black pigment, in a granular form, but the layers composing the walls, gradually become wholly indistinguishable. Ultimately nothing is visible but connective-tissue fibrils, covered with a finely granular substance, and it is only from the branching of the delicate cords that we are afforded any means for the diagnosis of the atrophied vessels.

The *veins* in the state of atrophy undergo essentially the same changes, modified by their peculiar anatomical conditions. The opacities in their walls, owing to the greater delicacy of the membranes, are less marked than in the arteries; they occur especially in the varicose enlargements so often met with, and close to the valves. The opacity and thickening of the walls is usually caused by a finely granular pigment-substance, deposited in spots. This anatomical change also occurs in the valves, and, combined with the diminished elasticity and contractility of the walls of the vessels, will give rise to secondary dilatations, the power of resistance against the pressure of the blood being thus lessened. In this case, also, as in that of the arteries, a primary dilatation, at the expense of the thickness of the walls of the vein (without any previous textural change of the latter), may take place.

The forms of the minute dilated veins (*vid.* fig. 46) are very various; sometimes simply flask-like, sometimes with several lateral protrusions, and often representing a complete chain of dilatations. They are most readily found in the subcutaneous and submucous tissues, especially in the integument of the lower extremities, of the *anus*, and in the bladder at the *caput trigonum*, &c.

Virchow has devoted special attention to the subject, and has arrived at this result: that partial vesicular dilatations in the smaller vessels, occur, in general, without any connexion with true inflammation. He compares the forms of these

dilatations with those in the larger vessels and in the heart, and finds that they are alike. We shall go more minutely into this interesting subject, when we come to consider the exudations, and the organized new-formations; it is proper here only to notice Virchow's *cavernous ectasis*, his fifth form—that kind of dilatation, namely, in which the separate *diverticula* of the vessel, with atrophy and thinning of the walls, together with the disappearance of the interstitial tissue, enlarge to such an extent, that, at last, the *septa* between them are partially destroyed, and the various *sacculi* become conjoined into an irregular cavity. We should not, however, like Virchow, refer to this category the cavernous tumours *teleangiectases* in general, but only those which, independently of any exudation and new-formation of blood-vessels and connective tissue, are due simply to the above-described dilatation of the vessels (very probably only of the minute veins). As instances of this kind, might be adduced the *teleangiectases*, which so frequently occur, especially in the lips and skin of old persons, and which are developed without any indication of inflammation.

§ 7. External integument and Mucous membranes.

A *general atrophy* of the external integument may be observed in old age, in general dropsy, in wasting chronic diseases, such as *tuberculosis*, *syphilis*, &c., characterised by a diminution of thickness of the *corium*, and smoothness of its surface. The little eminences upon it gradually disappear, and the superjacent *epidermis* being thus rendered less tense, falls into minute wrinkles. In addition to this, the sebaceous follicles are also atrophied, owing to which, the skin of aged individuals appears dry and scurfy. The defective nutrition induces a loosening of the hairs and their sheaths, whence the two may be readily extracted together, or fall out spontaneously. Even the sudoriparous glands diminish in number, nothing, as it would seem, being left of them, but a coloured substance. The *stratum mucosum* of the epidermis, or to speak more precisely, its pigment, also undergoes a change, for, as stated by Lobstein, it may be remarked, that in negroes, after the seventieth year, the black colour changes into a

yellow.[1] In a European woman of deep brunette complexion, G. Simon observed a great multitude of white spots. Microscopic examination of portions of the skin possessing the normal brownish hue, showed the presence, in the *rete Malpighii*, of numerous, tolerably dark-coloured pigment-granules, and scattered pigment-cells filled with smaller granules, whilst in the uncoloured portions, not a vestige of pigment could be discerned. No other change, either in thickness, or in any other respect, could be detected in these portions. Here we have an instance of spontaneous atrophy of the cutaneous pigment.

Local atrophies of the skin are induced by conditions interfering with the nutritive process, within a determinate space, and of these a great variety exists. They may, in general, be divided into *external* and *internal* conditions; the former consisting in a continued external mechanical pressure, which, by the compression of the cutaneous vessels, impedes the entrance of the nutritive fluid. The internal conditions are connected with exudations and organized new-formations. In a physiological sense, also, a disturbance of nutrition is caused by the considerable distension of the gravid *uterus*. The superjacent integuments being rendered smooth by the tension to which they are exposed, and the elevations and depressions on the surface rendered more level. But owing to the circumstance that the bundles of connective tissue in the *cutis* are not of uniform thickness, but are more voluminous in certain spots, and give off, as it were, a system of more and more delicate *fasciculi* in the interstices (*vid.* the newly formed areolar tissue, and the figure given of it in the General Part), it may be conceived that when the tension of the skin ceases (after parturition), those portions of the *corium* in which the stronger bundles are contained, will contract more forcibly than the intervening portions, owing to their innate elasticity. In consequence of this, the less retractile portions of the integument will appear to be surrounded by cicatriform contractions.

Opportunities are often afforded of obtaining for examination subcutaneous tumours, together with the tense skin covering them. These are most usually new-formations of various

[1] [This is certainly by no means always the case.—Ed.]

kinds, such as fibroid, desmoid, *sarcoma*, *steatoma*, &c., which, as they increase in volume, elevate and stretch the integuments over an indefinite extent of surface, in which the vessels are constricted by the pressure from within, so that the superjacent *corium* is rendered thin and smooth, and the *epidermis*, as in old persons, is readily thrown into wrinkles, being rendered dry and deprived of its oleaginous element; even the pigment in the *rete Malpighii* appears to be diminished; the hairs, sebaceous and sudoriparous glands often disappearing altogether. This process of atrophy is frequently complicated with an unequal distribution of the nutritive fluid, in consequence of which, hypertrophy is set up in parts of the tissue adjoining others in a state of atrophy. The hairs and sebaceous follicles especially, occasionally attain a considerable increase of volume, even in atrophied integument. The lanuginous hairs may attain to three or four times their normal size, and the sebaceous follicles, by the increase of their parenchyma, reach such enormous dimensions, as to be visible even to the naked eye as white nodules, of the size of millet seeds; but in this hypertrophied condition their nutrition not unfrequently ceases, and they are transformed into opaque, brownish-yellow, crumbling masses, and lose their lobate figure. The processes thus described, may be explained upon the supposition, that the supply of nutritive fluid is wholly cut off in several portions of the integument, thus atrophied; whilst, in very small, limited spots, a greater abundance of nutritive material is supplied.

The atrophy of the *corium* is also frequently limited to particular constituents in it. Thus, in *alopecia circumscripta* (*porrigo decalvans*, Willan), in the thin *corium*, together with the hairs, only the sebaceous follicles are absent, whilst the excretory ducts of the sudoriparous glands, and the latter themselves, may probably remain.

According to Engel, *atrophy of the mucous membranes* is a rare phenomenon. The changes exhibited in their texture in this condition present much analogy to those which have been described as taking place in the skin. In advanced age, a general atrophy of the mucous membranes may be observed, which is especially manifested in that of the digestive organs. Thus, the gastric mucous membrane gradually loses its more prominent plications and becomes smooth, the mucous coating

on the surface being diminished. Its thickness is lessened; the cæcal *sacculi* of the peptic glands appear to be reduced in number, and to become transformed into dirty yellowish-brown groups. In the *duodenum*, according to Engel's observations, the atrophy of the special glands is often very considerable; and we have frequently noticed a collapsed condition, and a rarefaction of the glands of "Brunner." The *villi* of the mucous membrane of the small intestine, without any appearance of inflammatory action, become clouded from the apex towards the base, pigmented, lessened in size, particularly in the transverse diameter, and even seem to be subject to a complete abolition; since, according to other observers, the number of *villi* is diminished. The *valvulæ conniventes* are less prominent than natural, the Peyerian and solitary glands collapse, their situation being often indicated merely by a pigmented border.

Substantive local atrophies of the mucous membrane, from insufficient general nutrition, certainly occur at an earlier period of life, in many diseases, and should not be confounded with the local atrophies consequent upon exudations. They seem to occur particularly in the intestinal mucous membrane in children, frequently, in the first year of life; but this change still requires more precise anatomical investigation.[1]

§ 8. Lungs

It is known that in old age the air-passages become dilated, as well as their vesicular terminations—the air-cells. As the walls of the latter contain no contractile elements, it has necessarily been assumed that the expulsion of the air from them, in expiration, is effected simply by the elasticity of the fibrous element in their walls. When this elasticity, as is the case in old age, is diminished in consequence of defective nutrition, the

[1] A particular form of atrophy of the mucous membrane of the stomach is described by Dr. H. Jones ('Man. of Pathological Anatomy,' p. 499), "consisting in the infiltration of a low fibroid tissue loaded with *nuclei* among the tubes, which themselves undergo atrophy, so that, at last, the mucous membrane loses its tubular aspect altogether, and becomes a semifibroid stratum." The same pathologist (ibid., p. 500) considers that the mamellated condition of the gastric mucous membrane depends on a process of local atrophy, at least in most cases, the tubes [be]ing wasted in the track of the furrows.

air-cell, after expiration, will by degrees be rendered incapable of regaining its pristine dimensions. The same thing may be said with respect to the *bronchiæ*, but in this case the contractile element is superadded. Thus is produced a vesicular *emphysema*, and a *bronchiectasis* of less amount.

Any dilatation of the air-cells must be connected with a state of tension of the very close capillary plexus surrounding them. In consequence of which, the due supply of blood is prevented, and a tendency to atrophy induced in the vessels constituting the plexus and in the walls of the air-cells; at the same time, perhaps, that a liability is incurred of the rupture of the less elastic cells, upon more powerful inspiration. In this way are produced, in emphysematous lungs, larger and smaller cavities, corresponding to larger or smaller groups of atrophied cells. In order to obtain a distinct view of this condition, a piece of emphysematous lung should be dried, and a portion taken from the surface. The appearance then displayed is shown in fig. 26. Cæcal cavities, of various forms and sizes, are at once apparent, in whose walls rounded or fissure-like openings may occasionally be noticed. The reticulated *trabeculæ*, which by reflected light are seen forming projections, consist for the most part of the interstitial connective tissue.

FIG. 26.

In higher degrees of atrophy of this kind, entire lobules at the periphery of the lungs are destroyed, and the *pleura* is frequently raised into hemispherical vesicles filled with air, which when opened, present a wide-meshed, trabecular tissue.

In the highest stage of the affection, the same process extends from the periphery towards the interior; and ultimately a whole lobe of the lung will lose its characteristic structure—the air-cells,—nothing remaining but the areolar *stroma*, in which the pulmonary parenchyma is wholly wanting.

The *emphysema* consequent upon exudative processes in the pulmonary *parenchyma*, and existing around the infiltrated portions, depends essentially and solely upon the impeded circulation and nutrition. In order to illustrate this, let us suppose the case of two air-cells supplied by the terminal

branches of a minute pulmonary artery. Let the cell *a* be filled with exudation, whilst the cell *b* is still filled with air. In *a* the circulation has certainly come to a stand, but it will also be obstructed in *b*, because *a* and *b* are both supplied by the same arterial branch, and the blood-corpuscles, which can no longer circulate around *a*, accumulate in the close capillary plexus of *b*, obstructing the passage of the blood through it. The cell-wall, *b*, after the *stasis* is established, will remain more distended when expiration takes place; or, in other words, its elasticity will be gradually diminished; the cell *b* consequently is in the same condition as the atrophied pulmonary cells above described. We are of opinion, therefore, that it may be stated as a general fact that the diminished elasticity of the air-cells is the cause of the retention of air after expiration has been performed, and that the increased volume or dilatation of the cell is simply produced by the too great tension ensuing upon the act of inspiration. At the same time it is impossible that a distended air-cell should much exceed its normal volume, and it is evident that the cavities arising from the atrophy of a whole group of pulmonary cells have been erroneously regarded as dilated air-cells.[1]

[1] [It does not appear quite clear from the expressions in the text, what the author's notion is with respect to the proximate cause of the dilatation of the air-cells, though it may be gathered that he attributes it to pressure consequent upon inspiration, and not to the difficulty of forcing the air out again upon expiration due to some obstruction in the *bronchiæ*. The discussion of this question in all its bearings would be out of place in a merely histological work, though one very proper to be undertaken in a work on general Pathology. But it may here be remarked that the hypothetical weakening of the walls of the air-cells from a diminished elasticity of the fibrous tissue contained in them, is by itself, even were it proved, quite insufficient to account for their dilatation; and, moreover, that the dilatation of the cells is of itself insufficient to prove that their walls are unduly weakened at all. We are inclined to adopt Dr. Gairdner's views on the subject of *emphysema*, supported as they are by him with very good reasons, and consonant with common physical principles. He states that *emphysema* is:—1. A lesion of mechanical origin. 2. That it is produced by the inspiration force [that is the pressure of the atmosphere in inspiration], and never during expiration. 3. That it is due *solely* and *exclusively* to the action of that force [pressure] upon the previously sound air-vesicles in lungs which have undergone, in other portions, atrophy or collapse, that is, *partial diminution of volume*. Which diminution of volume in a portion or portions of the lungs, he considers the sole pathological condition necessary for the production of emphysema. ('Brit. and For. Med.-Chir. Review,' vol. xi, p. 469, 1853.)—Ed.]

Another form of pulmonary atrophy is witnessed in cases where the air-cells collapse in consequence of pressure, so that the substance of the lung is hepatized and dense, as is well known to be the case in pleuritic exudations.

Among atrophies also may be enumerated the condition of the lungs termed *atelectasis*, which, as Reinhardt has shown, is attended with a fatty degeneration of the *epithelium* of the air-cells.

§ 9. Teeth.

The teeth are distinguished at different ages by a diminution of the pulp-cavity, an increase of thickness in the *cementum*, and a lessening of that of the enamel, and of the transparency of the three dental substances; by the edges and angles becoming blunted, and the surface assuming a yellow tinge, &c. These distinctions are most striking in the teeth of old men. In the *pulp* of teeth in this condition will be noticed a considerable diminution in the quantity of blood, the colour of that tissue often passing into a brownish yellow, from the quantity of pigment deposited in it. Earthy salts, assuming the outward form of the botryoidal corpuscles met with in the pineal gland, occur on the inner surface of the pulp-cavity and of the dental canal, and also deposited in groups in the substance of the pulp. An increased number of layers of *cementum* will be observed, though these are often concealed by the opaque, brownish-yellow colour of the intercorpuscular substance. In thin sections, the *dentin*, sometimes throughout, sometimes only in isolated spots, appears less transparent than natural, and the dentinal tubes become less distinct, and occasionally disappear altogether, in the dark grey or brownish-yellow substance. These partial opacities of the dentin are manifested even to the naked eye by a speckled appearance. The enamel presents dark, reddish-brown spots, and, as well as the dentin, appears to have lost some of its elasticity, and to have become more brittle.

Premature involution of the teeth is a very frequent phenomenon, depending not only upon general derangements of the nutritive conditions, as in *tuberculosis*, scurvy, gout, and *syphilis*, but also occurring to a partial extent as a consequence of local influences, such as uncleanliness, and indigestion. A great

influence in this respect has been attributed to the *fungi* and *infusoria* which are found in the tartar, amounting even to the erosion of the enamel. We do not believe that a *vibrio* can possibly injure the enamel, a substance for the most part of inorganic nature, nor that filamentary *fungi* should deprive it of its nutritive material; but are of opinion that putrefying substances which readily accumulate between the teeth may, by imbibition, injuriously affect the enamel, and produce those brownish-red spots, which are frequently met with, especially at the neck of the tooth, and consequently in the part most exposed to the influence of the putrefying matter; and which have been described by dentists as the commencement of dry *caries*. This partial *necrosis* (a sort of decay), as which we would describe it, is the more pernicious to the tooth, since at its neck, and in the conical depressions of the molar teeth, the layer of enamel is thinner than elsewhere, and the dentin more readily exposed, when, as we have supposed to be probable, the fragility of the necrosed enamel is increased. When the latter is cracked off in one or more places, the putrefying matters will exert their pernicious influence at once upon the dentin, and owing to the greater capacity for imbibition possessed by that tissue, the *necrosis* will advance with proportionately increased rapidity, until at last, as a consequence of the irritation produced by the foreign matter, an inflammation of the pulp ensues as a secondary phenomenon. If the destruction proceed from within to without, and originate in an exudative process in the pulp, the *caries* is termed "moist." This affection, owing to the imbibition of the exudation from the dental cavity, produces a more rapid destruction of the porous dentin, and particularly at the spot where the principal mass of the exudation is deposited. The dead portions of dentin and enamel exfoliate, and are often distinguishable as such under the microscope. An entire abolition of the nutrition of the teeth may take place in consequence of an exudation, *necrosis*, new-formation of cellular tissue, &c., in the alveolar processes.

§ 10. Liver.

The elementary contituents of the liver, under unfavorable nutritive conditions, as, for instance, in chronic *tuberculosis*, are

very frequently subject to different modes of involution, of which we will first consider those which occur in the *fatty liver*.

In this case an accumulation of sometimes rather minute fat-globules is observed to take place in the hepatic cells; these globules appear to lie, as it were, upon the flattened cells, although their movements manifestly correspond with those of the latter when water is dropped upon them (fig. 27). The fat-globules frequently attain to such dimensions as nearly or entirely to fill the hepatic cell, whose existence is indicated only by the small projecting angles. In the most advanced stage of this form of degeneration, the cells apparently burst. In order to obtain a view of the mode in which the fat is distributed in the "fatty liver," a thin section should be made, either with the hand unsupported, or, what is better, by means of the double-bladed knife. *The fat-globules appear to be dispersed universally in the dirty-yellow hepatic substance.* But upon closer inspection, together with the cells containing fat, others will be seen, filled with dark pigment (upper row of cells in fig. 27), occasionally of a brownish-black colour, and wrinkled appearance, and usually situated around the central vein of a lobule. The blood-vessels are in an anæmic condition, and there is no doubt that in many lobules they become atrophied in proportion to the destruction of the hepatic cells; this destruction sometimes proceeds to such an extent that in many places scarcely a single cell retaining its polygonal form can be perceived, nothing being seen, as remains of the hepatic cells, but free fat, molecular substance and *nuclei*. This condition, which may be briefly expressed as a *softening* of the fatty liver, must not, in any way, be confounded with Rokitansky's "yellow atrophy," which is accompanied with other physical and morbid phenomena. We are unacquainted with the more intimate pathological processes attending this change, but believe that the fatty liver in general, and especially this form, which is described by Rokitansky as peculiar to *tuberculosis*, should not be referred to the category of hypertrophies, since the elementary organs present a retrograde condition of nutrition, particularly in the accumulation of fat in

FIG. 27.

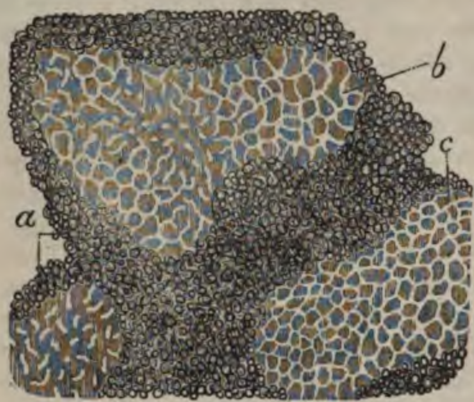
their interior. It appears to us most probable that this first modification of the fatty liver of Rokitansky, which occurs so frequently in *tuberculosis*, originates in a too great amount of fat in the blood of the *vena portæ*, which, circulating in the portal capillary system, affords an insufficient nutriment to the hepatic cells in consequence of its abounding in fat. We consequently find the *olein* dispersed throughout the substance of the liver, and term this abnormal condition, the *lobular fatty-liver* to distinguish it from that next to be described—the inter-lobular.

It might be objected to this, that in the form of fatty liver, thus named by us and assigned to the category of atrophies, not only is there no diminution of bulk, but on the contrary an increase. But if it be considered that, together with the fat deposited in the cells, no inconsiderable quantity of the same element is introduced into the substance of the liver, and that the proper glandular parenchyma—the cells—can in no way be supposed to be increased, it will be clear that the increased bulk of the liver is caused by the accumulation of fat in the intercellular fluid. Going still further, and taking into account the sluggish circulation and absorption always going on in the liver, we shall find additional reason for the circumstance that when the portal blood probably contains a larger amount of fatty matter and the vital energies of the organ are lowered, a greater amount of fat will accumulate in it.

Rokitansky has established the existence of a second modification of fatty liver independent of *tuberculosis*. According to him, it occurs in a high degree as the consequence of luxurious living, want of exercise, of over feeding in children, and, above all, from the immoderate use of alcohol. Without entering into any more precise anatomical exposition, he describes the commencement of the fatty liver as a peculiar kind of "nutmeg-liver." If a liver in the commencing stage of fatty degeneration, and having the "nutmeg" appearance, be examined, a red and a white substance will be at once noticed, of which the latter was at one time erroneously regarded as the secretory element. Thin sections at once show, that the white substance is due to an accumulation of free fat, the red corresponding to the portal capillaries filled with blood. In

fig. 28, *a*, we see a great many free fat-globules, which are in such close apposition as mutually to cover each other, and greatly to obstruct the transmission of light. By reflected light they appear white, and consequently represent the so-termed white substance, surrounding the red. In the hepatic lobule, *b*, *c*, the light coloured network represents the portal capillary system distended with blood, whilst the shaded interspaces indicate the hepatic cells. It is evident that, in an extensive section, the hepatic lobules will occur divided in various directions, and consequently, that not only will their outlines assume, sometimes rounded or elongated, sometimes various irregular figures, but also that the capillaries and the central veins, in transverse, oblique, or longitudinal sections, will appear as red points, or as isolated or reticulated red streaks.

Fig. 28.



The hepatic cells, although their contents are also in a state of incipient fatty degeneration, nevertheless do not, as in the former kind of fatty liver, present fat distributed universally in their interstices, but the fat is collected between the lobules, whence we think that this form of fatty liver should be designated the "*interlobular*." But this term is appropriate only to a particular stage, for nutmeg-fatty-livers also occur, in some of whose lobules a greyish discoloration, due to free fat-globules, will be perceived surrounding the central vein, indicated in those lobules, in which it is divided transversely, by a circumscribed red spot, of some size, in the centre of the lobule.

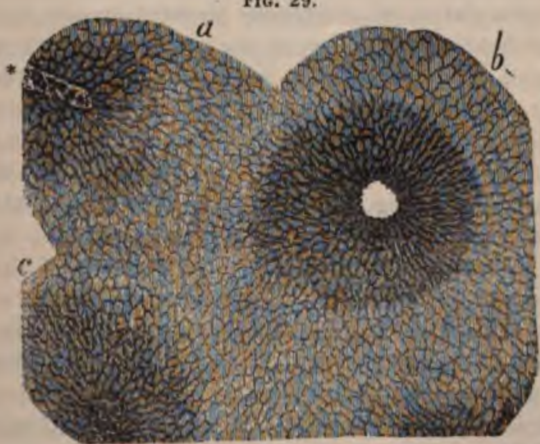
From this anatomical exposition it is manifest, therefore, that in the nutmeg-fatty-liver, the deposition of free fat advances from the peripheral—or interlobular—towards the central or intralobular veins. It is evident, therefore, that it originates from the former.

In more advanced stages of the affection, the proper hepatic *parenchyma* is greatly concealed by the deposit of fat, and the cells contain brownish-yellow molecules and fat-globules, often remarkably dark. Free pigment also occurs in the capsule of Glisson.

The interlobular fatty liver is connected with a hyperæmic condition of the portal system. The circulation which, notwithstanding the accumulation of fat between the lobules, still proceeds, as is shown by the capillaries being filled with blood, ceases in those parts of the liver in which the fatty degeneration is more advanced, the cessation being attended with shrinking, the deposition of pigment and absence of blood.

There is still another kind of nutmeg-liver, which must also be arranged with the atrophies, which we will exemplify by an instance. In a man dead of lead-poisoning, and who had been paralysed in the upper extremities, the anæmic hepatic substance was of two distinct colours, one brownish-red, and the other, which was interstitial, light yellow. Thin sections made by means of the double-bladed knife showed that the dark colour was situated around the central veins (fig. 29). In the

Fig. 29.



lobule, *a*, the central vessel at *, which is divided nearly in its longitudinal axis, is partly filled with a black, amorphous, crumbling substance; in the lobule, *b*, the central vein is divided transversely, but the contents have escaped, so that it

appears as a light central spot; in the lobule *c*, lastly, the central vein, which is cut nearly transversely, is manifestly filled with coloured contents. Around these veins may be observed a dark-coloured plexus, rather abruptly defined towards the exterior, and in its formation resembling the capillary plexus of the liver. The colour could not be removed by water, acetic acid, or carbonate of soda. Isolated hepatic cells, from the dark portions, contained an agglomeration of brownish-yellow molecules, which had a tendency to adhere to one side of the wall. No capillaries containing pigment could be perceived. It may hence be assumed that this apparently capillary pigmentation should be ascribed merely to an accumulation of pigment-molecules towards one side of the hepatic cells. This view is also supported by the circumstance that no accumulation of pigment-molecules existed in the hepatic cells in the peripheral, lighter coloured portions of the lobules. In many sections, also, the black, amorphous, crumbling masses noticed in the central veins, occurred in longitudinal rows; they were evidently contained in the larger and smaller hepatic veins running between the lobules. There was nowhere any indication of an accumulation of fat.

The accumulation of amorphous pigment-masses in the hepatic veins extending as far as to the central vein, proves that a *stasis* of the blood must have been established in them, inducing an atrophy of the capillary system. We would term this form of atrophy the *pigmented nutmeg-* or *intralobular pigmented atrophy*. Speaking generally, it is more rare than the former kind of nutmeg-liver which we have termed the *interlobular fatty liver*, though frequently associated with it. The pale liver of a woman who had died of *necrosis* of the upper jaw produced by *phosphorus*, was of tough consistence. The central portions of the hepatic lobules contained yellow-brown pigment, and corresponded with the parts, which, to the naked eye, presented a dirty yellow colour. The peripheral portions of the lobules, viewed by transmitted light, appeared opaque, in a state of fatty degeneration, and formed those portions of the liver which by reflected light presented a dirty white hue. The pigment and fat existed free, as well as enclosed in the hepatic cells; the central cells, consequently, had undergone pigmentary degeneration, and the peripheral the fatty.

Of these combinations, again, very numerous intermediate forms are met with, as regards the colour and amount of pigment, the extent of the fatty deposit, and of the obliteration of the vascular ramifications, whence the surface of the liver is rendered uneven and presents nodular elevations. On section, the texture is firmer, and the atrophied groups of lobules appear in the form of dirty yellow or rusty-brown, rounded portions. This higher degree of atrophy corresponds with that described by Engel as the second form of hepatic atrophy. He has also shown that it differs from granular liver, which depends upon the development of a new callous tissue in the hepatic *parenchyma,* and to which we shall return in speaking of the new-formations of connective tissue in the liver.

A *serous degeneration* of the intercellular substance of the liver, constitutes the *œdema,* which may be associated with various forms of atrophy. Engel has stated that the forms described under the names of "waxy liver," may be pervaded by colourless matters, only the amount of water is not so considerable as to ooze in any quantity from the surface of an incision. Thus in the interlobular fatty liver, which also frequently contains pigment in the centre of the lobules, and usually occurs in conjunction with cardiac disease, a watery, sanguineous fluid exists in the hepatic *parenchyma.* The *yellow* and *red* atrophies of Rokitansky, we are inclined, with Engel, to regard not as atrophies, but among the effects of exudative processes, which have caused a fusion of the hepatic *parenchyma* (*vid.* "exudations"). We also think that the so-termed *lardaceous liver* has a better claim to be placed among colloid exudations.

§ 11. Blood-vascular Glands.

Atrophy of the spleen is characterised by the large amount of pigment contained in its substance. In this condition of the spleen the blood-corpuscles undergo those retrograde metamorphoses or forms of involution which have been described more minutely under the head of "Atrophy of the Blood." In the more advanced stages of atrophy of the spleen, we find neither the so-termed blood-corpuscle-holding cells, nor the pigmented granule-cells which, according to Kölliker, are derived from them. The *nuclei* which are contained in the

normal splenic cells, as well as the white blood-corpuscles, the parenchymatous- and fibre-cells are more scanty. It is usually difficult to free the *trabeculæ*, from the interposed molecular and pigmented substances, which latter are seen in groups, varying in colour from deep yellow to black. The reddish-brown granules sometimes attain to the size of a blood-corpuscle or exceed it, and probably arise from blood-corpuscles cohering in groups, and which have undergone involution. Accumulations of fat are not seen.

The capsule of the spleen is thickened by the deposition of a fine molecular material, and the fibres are less easily displayed than usual. In senile atrophy of the spleen, the capsule often contains cartilaginous or ossified patches. In the substance of these patches, Rokitansky has noticed cretified arterial ramifications, and also free calcareous concretions in the veins (phlebolites).

Atrophy of the *thyroid gland* is indicated by its dirty-yellow aspect, the collapse of the lobules, and diminished transparency of the substance, in thin sections. The gland-vesicles are rarefied, or, in many places, even no longer visible, being replaced by a fine-granular, dark, brownish-yellow or reddish-brown substance. The connective tissue, which is brought more prominently into view owing to the shrinking of the vesicles, renders the atrophied portions tougher. Similar atrophic conditions are manifested in cystic sarcoma of the thyroid (Cystenkropf) in the tissue surrounding the cysts, and will be more particularly adverted to when we come to speak of new-formations of connective-tissue.

A. Ecker was the first to notice the *premature atrophy of the thymus gland*. In the bodies of four children dead of pneumonia (from 8 days, to 4 and 6 months, and 2 years old) he found the *thymus* soft and flabby, viscous and yellow; it contained nothing but fatty granules, and only a few scattered vestiges of the gland-*nuclei*, &c., so that under the microscope the *acini* appeared quite opaque and black. This is a condition into which otherwise the gland does not fall till after puberty. We have sometimes had an opportunity of noticing this premature atrophy of the *thymus* in the form described by Ecker, particularly in children affected with *marasmus*.

§ 12. Kidneys.

In aged individuals, the shrinking of this organ, and especially of its cortical substance, belongs to the usual class of phenomena of the same kind. The surface appears nodulated, and of a dirty, yellowish-red colour; the consistence of the organ is sometimes denser, sometimes softer than natural. The shrunken *tubuli uriniferi*, assembled into groups, and forming *sacculi* or pouches filled with a fine-granular material, constitute the rounded elevations on the surface of the gland. The proper characteristic of the renal substance, that is to say the *tubuli uriniferi*, and Malpighian corpuscles, are destroyed at the atrophying surface, in proportion to the degree of atrophy which the gland has undergone; the Malpighian corpuscles becoming wholly unrecognizable. The medullary substance is occasionally rendered more dense, and acquires a dirty, light-yellow colour, from the presence of molecules resembling fat-globules. With these are frequently associated atheromatous deposits in the larger vessels, or even in the capillaries themselves, a collection of renal sand, or minute *calculi*, and enlargement of the *pelvis* of the kidney. This atrophy, should be distinguished from that accompanying Bright's disease, and which originates either in an exudative process, or frequently in a new-formation of connective tissue in the interstitial substance of the renal *parenchyma*. In *paralysis* of the organic muscular fibres of the *pelvis* of the kidney, and of the *ureter*, those parts become dilated, and an accumulation of epithelium takes place in them.

§ 13. Female sexual Organs, &c.

The premature atrophy of the *ovaries* and *uterus*, especially of the former, when the Graafian follicles collapse, and the organ exhibits a wrinkled surface, frequently occurs in a minor degree. In several instances of this kind, we have been unable to find more than a single follicle together with the ovule, in the *parenchyma* of the ovary; nothing was presented but connective-tissue-bundles with numerous brownish-yellow and reddish-brown free pigment. Occasionally, also, deposits of calcareous salts take place on the surface of the organ.

In the atrophied tissue of the *uterus*, even on the surface of a section, the vascular trunks, in a state of involution, are occasionally visible in the form of empty canals, with the walls undergoing fatty degeneration. All indication of the organic muscular fibres is lost, nothing remaining but a dense connective tissue. The mucous membrane becomes thin, soft, and pale.

The *placenta* is not unfrequently insufficiently nourished on the side of the *uterus*, and consequently undergoes morphological changes. The most striking are those which occur in connexion with miscarriages from the sixth to the ninth months when the *fœtus* is dead. The most usual alteration consists in an accumulation of a dark yellowish or greyish-brown molecular substance, which renders the *villi*, with their clavate extremities, almost opaque (fig. 30, *a*), or merely diminishes their proper transparency at the point (*b*). This metamorphosis of the *villi* usually extends over entire groups; and it may be very strongly marked in many parts of the *placenta*, whilst in others it is very faintly indicated or entirely absent. It is more developed on the convex than on the concave side of the *placenta*, and is connected with an absence of blood in the affected portions.

Fig. 30.

The same transformation of the contents of the *villi* into an opaque molecular substance we regard as indicative of an imperfect nutrition, which frequently takes place also in the aborted human *ovum*, even in the earlier months. The young *villi* of the *chorion* presenting the aspect of globular processes, are not unfrequently infiltrated with a dark grey or brownish-black, molecular material. In the more advanced stages of this retrograde development, the diameter of the *villi* is lessened, and entire groups of them collapse, being rendered evident to the naked eye by a dirty yellow appearance.

As the atrophy advances from the periphery towards the centre, from the apex of the loop of each *villus* towards its peduncle, it is intelligible why it is that the latter is usually not occupied throughout its length with the opaque material; with which, however, it is often wholly or partially filled.

The degree to which the atrophy has advanced may be estimated by the extent to which this kind of metamorphosis can be traced towards the thicker stems of the *villi*. The connective-tissue elements of the stem are frequently in a state of fatty degeneration, that is to say, brilliant molecules of considerable size are visible in the fibre-cells, from which the *nucleus* has escaped, or a chain of fatty molecules may be seen in the more slender fusiform fibres.

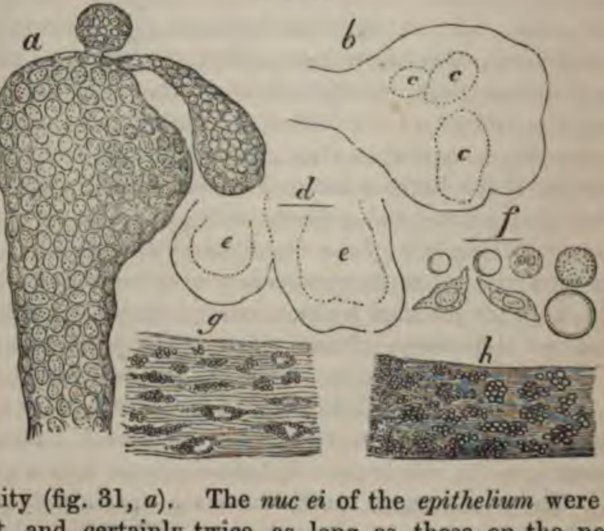
When attention is directed to the vessels, the larger branches of the umbilical arteries in the *placenta* of an aborted fœtus will be found to present atheromatous deposits, obvious to the naked eye by a yellowish colour, local thickening, and opacity of the walls of the vessels. Closer examination shows, in their walls, the deposition of fine-molecular masses, and occasionally of fat-globules of considerable size; a process analogous in all respects to that represented in (fig. 25). Similar retrograde metamorphoses may also be observed in the arteries in the umbilical cord, though not extending further than to about two inches from its insertion into the *placenta*. Under these circumstances it is obvious enough that the organic muscular layer of these arteries is in a state of degeneration, in consequence of which, it may be conceived that the circulation will be retarded.

The *œdema* of the umbilical cord, usually observed in the aborted *fœtus* in cases of premature birth, consists in an accumulation of serous fluid in the *areolæ* of the connective tissue, whence the volume of the latter is considerably augmented. It is attended with discoloration of the navel string, when the maceration of the fœtus is more advanced. In this case, therefore, we have a fatty and pigmented degeneration of the connective-tissue elements of the umbilical cord.

We have rarely had an opportunity of witnessing the *œdema of the villi* of the placenta which occurs in the latter months of pregnancy; and *œdema* of the *placenta*, independently of the *villi*, we have but once noticed with Dr. Späth. On the other hand, the collection of a hyaline fluid in the *villi* of the parts in question is often seen in the earlier months. Under these circumstances the *villi* become distended almost into a globular form. The elementary constituents also participate in the serous degeneration. An aborted *ovum*, 2·75 inches long, came

away from a woman, who, according to Dr. Herzfelder, had in the previous year aborted in the 5—7th week. The form of the *ovum* was more depressed than usual; and scarcely more than a few drops of fluid escaped when the *amnion* was opened. The cavity of the latter was completely flattened, and in one part it contained a blood-coagulum adherent to the wall, and at another point diametrically opposite, a depressed body, 0·275 inch in length projected;—this body was attached to the membranes of the *ovum*, and consisted of a molecular substance for the most part opaque, presenting here and there a membranous covering, and containing minute, rounded, elements in a state of fatty degeneration. It obviously represented the atrophied *embryo*. The elementary constituents of the very soft and relaxed *chorion* were in many places in an advanced stage of fatty degeneration and loaded with groups of granular corpuscles; the *villi* and their stems were filled with a molecular material, and close to them were seen minute, opaque, apoplectic effusions. In the thicker part of the *chorion* there was a cystic cavity, at the bottom of which were *villi*, visible to the naked eye, in a state of serous degeneration. They were hyaline, and considerably enlarged towards their clavate

Fig. 31.



extremity (fig. 31, *a*). The *nuc ei* of the *epithelium* were very distinct, and certainly twice as long as those on the normal

villi. Seated on the *villus*, *a*, may furthermore be noticed a spherical, and a retort-shaped *villus*, attached by constricted peduncles.

Besides the large epithelial *nuclei*, especially on the expanded ends of the *villi*, might be remarked larger and smaller, rounded or irregular, hyaline spaces, which were occasionally visible in the dilated portions. In fig. 31, *b* and *d*, represent the outlines of enlarged extremities of *villi*, with the hyaline spaces, *c*, *c*, *c*, and *e*, *e*, (shown by the dotted lines; the *epithelium* covering the spaces in question, and the entire *villus* being omitted). The stems of those *villi* which, as above noticed, were not distended by a watery fluid, contained an abundance of fibre-cells in a state of fatty degeneration (*g*), or groups of fatty molecules (*h*), by which the fibrous elements were occasionally completely concealed. The interstitial substance of the *villus* afforded light-coloured, spherical *nuclei* of considerable size, isolated spherical *nuclei* with a double contour, spherical, granular corpuscles, occasionally containing one or more, rather large molecules (*nucleoli ?*) and cells with processes.

With respect to these cells, it might be inquired whether they are to be regarded as parenchymatous cells in a state of serous degeneration, or as incipient, new-formed, connective-tissue elements in a similar condition. In our opinion, the latter view is the more probable.

These serous degenerations of the *villi* are frequently still more remarkable when they occur at an earlier period of the formation of the *chorion*, in which case they are connected with a complete dissolution of the *fœtus*. Fig. 32, *a*, represents a serous *villus* of the *chorion* of an *ovum* at four weeks, in which the cells had entirely disappeared, and the large hyaline spaces occupied nearly the whole *villus*, a delicate molecular material being accumulated towards the investing membrane. Many other *villi* presented spots composed of an opaque molecular substance. The collection of *serum* not being uniformly distributed, produced nodular elevations in the very long pedunculated *villi*, the younger of which (*b*) not unfrequently exhibited their state of serous degeneration in considerable-sized light-coloured spots. When the *villi* were torn asunder, the cells (*c*) escaped in considerable number, characterised by their size (0·08—0·26‴), and containing disproportionately large,

Fig. 32.

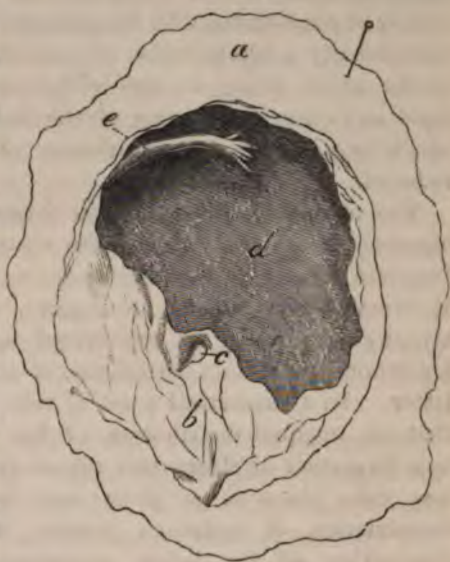
vesicular *nuclei.* We regard these as immature, newly-developed elements of connective tissue (*vid. sup.* New-formations of connective tissue).

Of precisely analogous nature, but on a much larger scale, is the serous degeneration, in what is termed the *mola hydatidosa,* only that in this case the formation of connective tissue predominates so much that the growth must be referred to that category. *Villi,* nevertheless, are met with, which must be ranked with those last described. At *d,* is shown a *villus* of this sort, taken from a *mola hydatidosa,* which, together with the large light spaces, presents on one side towards the base the rudiments of the *epithelium.* The other very various forms of *mola* depending upon a new formation of connective tissue, do not belong here, and the account of them must be sought for under the head of "New formations of connective tissue."

As a consequence of insufficient nutriment afforded from the uterine blood to the developing *ovum,* we regard the condition in which *dropsy of the amnion* is gradually developed, terminating in a partial or complete *solution of the embryo.* We will here mention a case in which the latter was particularly evident. The case was that of an *ovum* at about the third month, and of which the cavity measured 2·34″ in its longest diameter. [illegible]*orion,* which was already much thickened at one side

(fig. 33 *a*), exhibited dirty-yellow circumscribed spots, of rather firm consistence, and not easily torn by the needles; there was a well marked and far advanced molecular infiltration of the *villi* which also contained immature connective-tissue elements, as in fig. 32 *c*. In the centre of the elliptical *chorion* was a sanguineous infiltration about $2{\cdot}21'''$ thick. On the outer surface of the folded membrane of the *amnion*, which in the figure is represented as partially removed in order to display the internal

Fig. 33.



cavity, is seen the umbilical vesicle (*c*), from which a short filament proceeded. From the upper segment of the wider extremity of the cavity (*d*) projected the somewhat enlarged, pulpy umbilical cord (*e*), $0{\cdot}46''$ in length, from which depended a fimbriated body scarcely $0{\cdot}44'''$ in length, and having two short lateral processes, which floated out under water, together with the umbilical cord.

In addition to the form of *œdema* of the *umbilical cord* which has been more particularly described above, and which usually occurs in the macerated fœtus in cases of premature birth, we have here to notice a special kind, which might be termed the *vesicular œdema* of the umbilical cord, and is probably to be referred to a torsion or powerful extension of it. This form of *œdema* is frequently observed in small embryos in the third or fourth month. We have selected for illustration an embryo measuring from the *vertex* to the *nates* $0{\cdot}78''$, and from the bend of the neck to the same point $0{\cdot}5''$ (fig. 34).

Fig. 34.

On the anterior wall of the abdomen was observed a compressed, vesicular expansion of the umbilical cord, measuring in its longer diameter about 0·35″, and which, at an earlier period, might readily be confounded with the umbilical vesicle and the *allantois*. Occasionally a whole series of similar vesicular enlargements of the navel string is met with, produced probably by the rapid and energetic turning of the *embryo* upon its axis; and which originate in the disturbance of the circulation thence induced.

The atrophied morphological forms, just described, of the *placenta* or of the *chorion*, are never absent in macerated, dissolved *fœtuses*, at any rate so far as our observations extend. It remains now further to inquire, whether these forms of atrophy are primary or consequent upon exudations or new-formations in certain situations, or are simultaneous with the latter. In a theoretical point of view, it is easily conceivable that an unequal distribution of the nutritive matter, viz., a new formation of elementary organs (young connective-tissue), may take place at a given spot from the superabundant transudation of nutritive *plasma*, whilst the simultaneous deprivation of the latter, experienced in other situations, would induce certain forms of involution. In the latter case, consequently, atrophies and new-formations would be co-effects. On the other hand, the two former possibilities may be entertained, for it may be that too little nutriment is afforded from the surface of the *uterus*, in consequence of which, certain portions of the *placenta* or of the *chorion* would be reduced *primarily* to a state of atrophy; or a *nimium* of nutritive matter might give rise to the deposition of exudations and the new formation of elements, which, on their part again, would cause a secondary impediment to the circulation.

As experience shows the very frequent occurrence of atrophies, exudations, and new-formations, in the *placenta* or in the *chorion*, we must conclude that they are usually to be regarded as co-effects.

Since the contact of the fœtal blood circulating in the *placenta*, with that contained in the vessels of the walls of the *uterus*, is rendered impossible in the atrophied condition of the groups of *villi*, inasmuch as blood is no longer admitted into the latter, the nutrition of the *embryo* will suffer in pro-

portion to the number of groups so affected. The farther the atrophy has advanced from the periphery towards the centre, —that is to say, from the *apices* of the *villi* towards the peduncles and stems,—so much a higher stage has it reached. If, in addition to this, the larger trunks of the vessels—the branches of the umbilical arteries—have their nutritive conditions disturbed, the rapidity of the current of the circulating blood will be diminished, and both these factors of the atrophy—the peripheral and the central—will concur in causing the death of the *embryo*. It should also be considered, that the organs of the embryo must, likewise, necessarily be subjected to a gradual retrograde development, since the blood supplied to them through the navel-string has not undergone that change, at the inner surface of the *uterus*, which is requisite for the restoration of the nutritive fluid of the *embryo*.

We would here remark, at the same time, that the atrophied tissues of the *placenta*, or of the *chorion*, afford occasion to *apoplexies*, which largely conduce to the immediate death of the *embryo*. These *apoplexies* occur most frequently and most extensively about the third month of pregnancy, a circumstance, doubtless, to be ascribed to the development of blood-vessels which takes place at that time. The vessels which first make their appearance in the *chorion* are by no means capillaries or minute twigs, but of considerable dimensions. They are rounded cæcal passages, characterised by their containing blood, and are visible, even to the naked eye, as minute bloody points. Tubular processes are given off from these sanguineous *sacculi*, become filled with new-formed blood, and communicate with each other. Now if we suppose that the delicate-walled blood-canals are themselves involved in the retrograde *metamorphosis*, it is obvious that their rupture, and a consequent extravasation of blood, would very readily take place. To this is superadded the circumstance, that, in consequence of the exudation which is poured out in a given spot, the walls of the vessels are softened, in which way, also, the rupture of the latter is rendered possible.

The apoplectic effusion will have the more deleterious effect upon the embryo, the more suddenly the circulation in the large vascular trunks has been impeded by its diffusion. The

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dimensions of these extravasations are in general greater in *placentas* at an early date, and perhaps, as above stated, in the third month. In the *parenchyma* of the *placenta*, in the last months of pregnancy, apoplexies are rare, and the extravasations also of comparatively less extent. On the other hand, they cannot take place in the coverings of the *ovum* in the first weeks, because at that time vessels have not been developed in them.[1]

The study of the *atrophy* of the *lacteal glands* should be commenced in aged individuals. C. Langer was the first accurately to comprehend and describe the climacteric involution of these glands. He found several glands in old women in such a state of retrograde development that not a vestige of the *stroma* was any longer discernible; it was replaced by large deposits of fat, and the glandular tissue was represented by nothing more than the convolutions of tolerably wide canals filled with a greenish-yellow fluid. This fluid contained elements like those of milk; he frequently, also, observed varicosities of the canals filled with a similar fluid. Whatever were the dimensions of the *mamma*, nothing but fat, together with these canals, was found, the latter running in the cellular, mem-

[1] [For further information respecting what is termed fatty degeneration of the *placenta*, reference may be made to the observations of Dr. R. Barnes and Dr. Hassall, and of Mr. Druitt, in the 34th and 36th volumes of the 'Med.-Chir. Transactions,' and to some useful observations by Dr. H. Jones, contained in an article on "Fatty Degeneration," in the eleventh volume of the 'Medico-Chirurgical Review,' p. 352.

It seems probable that the condition of the *placenta* termed fatty degeneration depends upon different causes:—1. There is great reason for believing with Mr. Druitt, that in many cases a deposition of oil and the partial obliteration of the vessels in the placental *villi* is a normal condition of the *placenta* at the end of pregnancy; and that when occurring in the earlier months, it *may* arise from some antecedent cause referable to the condition of the *fœtus*.

2. It would seem to be quite clear, however, from many facts contained in Dr. Barnes' memoirs, and especially from one adverted to in a note, at the end of his first paper ('Med.-Chir. Trans.,' vol. xxxiv, p. 201), that the oily matter may in some cases be derived from the *detritus* of fibrinous deposits in the substance of the *placenta*, as he himself hints, and as Dr. H. Jones (loc. cit.), takes considerable pains to point out.

Atrophy of the *placenta*, therefore, may be regarded as, at least, of two kinds—the one direct, from want of use of the part—the other, consequent upon some previous effusion or other morbid change in the *placenta* itself, or in its relations to the *uterus*.—Ed.]

branous sheaths of the fat-lobules. Injections could be thrown only to a certain distance into these canals, which terminated in blind clavate extremities. Their impervious, atrophied continuations could be traced a little further in the surrounding connective tissue, until they ultimately disappeared, being broken up, as it were, into fibres.

These statements of C. Langer, fully apply to the conditions presented in the mammary structure in *cancer*, and cystic *sarcoma* of the breast, to which we shall recur in the course of the work.

§ 14. Nerves.

Lobstein found that the nerves of old persons were drier than in individuals of a less advanced age. He noticed that this condition of dryness was always more evident in the branches of the great sympathetic, than in the nerves proceeding from the brain and *medulla oblongata*. This absence of moisture is to be attributed partly to the atrophy of the nutrient vessels running in the *neurilemma* and in the interstices between the nerve-tubes, and partly to the wasting of the nerve-medulla in the primitive tubules. Engel has observed the nerves, especially in advanced age, to be flat, thin, flaccid, lacerable, and enclosed in a thick mass of fat, which also penetrated among the *fasciculi* of the nerve.

The proper nerve-substance, and the interstitial connective tissue of a nerve, may be completely atrophied in consequence of continued pressure, so that of the larger trunks nothing may remain but the external fibrous tunic, forming a kind of bridge between the central and peripheral portions, thus parted, as it were, by constriction. In morbid growths, *sarcoma*, *cancer*, aneurisms, &c., a total or partial atrophy of the nerves of this kind may be observed.

According to Rokitansky, the bronchial plexuses of the *vagus* nerve, belonging to tubercular bronchial glands, are occasionally subject to atrophy, proceeding to such an extent as ultimately to lead to a complete interruption of continuity. The nerve, under these circumstances is, not unfrequently, at first flattened, its *fasciculi* being separated from each other, and finally it disappears altogether. Above and below the

point of lesion, the nerve, according to this observer, preserves its normal thickness.

Nasse[1] was the first to institute precise investigations with respect to the altered anatomical characters of divided nerve-fibres, and to state that the primitive fibres underwent a process of solution; they lose their cylindrical aspect, and acquire transverse striations, so as to appear to be divided into cylindrical segments, in length nearly equal to the diameter of the fibres. These transverse lines arise in a curling up and invagination of the fibres. At the same time, minute fat-globules are developed in the nerve, from the decomposing *medulla*, owing to which the fibre is rendered darker and less transparent. Ultimately, the walls also, of the nerve-tubes, disappear. Schiff found the same essential characters to be presented in all nerves, which during life have been for some time cut off from communication with the central organs to which they belong. The central portion of the divided nerve did not exhibit these changes; except that when the paralysis was of long standing, the fibres appeared to become flattened. Schiff also observed very distinctly, after the removal of the spinal cord in Pigeons, corresponding to the second and third dorsal *vertebræ*, and in the Guinea-pig, of the portion corresponding to the second lumbar *vertebra*, the characteristic changes in the *rami communicantes*, plexuses, and branches of of the sympathetic nerve, below the seat of injury.[2]

[1] Müller's 'Archiv,' 1839.

[2] [Not knowing where Schiff's observations are to be met with, I am unable to determine what claim he has to priority in the discovery referred to in the text. The first observations with respect to the condition of divided nerves, whose results agree with those of subsequent inquirers—appear to be those of Nasse (Müll. 'Archiv,' 1839, p. 409), who was followed by Gunther and Schön (ib., 1840, p. 276); and in the 'Philosophical Transactions,' 1850, part ii, p. 423, is a paper on the same subject, by Dr. A. Waller, whose experiments were limited to the section of the glosso-pharyngeal, and of the hypoglossal nerves in the Frog, which so far as they go, fully confirm and extend the results at which Nasse, and Gunther, and Schön had arrived. Dr. Türck ('Ueber Secondäre Erkränkung einzelner Rücken-mark-stränge,' Wien, 1851), quoted by Mr. Paget, in his valuable Lectures on 'Surgical Pathology,' has further shown that after diseases of parts of the brain and spinal cord, there gradually ensues a softening, as by atrophy, of those tracts or columns of the cerebro-spinal axis, through which in health impressions are conveyed from the diseased part.

It would seem, therefore, that where a nerve is divided, or in any way cut off from

Another form of partial atrophy of the nerves, is brought about by an increase of the interstitial connective tissue, in consequence of which the nerve-tubes appear, as it were, to become rarefied. This kind of atrophy may be observed in amputated limbs. In order to view it, careful longitudinal sections of the dense, tough nerves, must be prepared, and the transparent slices examined for nerve-tubes, with the aid of a dilute solution of carbonate of soda or of potass. The isolated and rarefied tubes in the bulbous extremity of the nervous trunk of a cicatrized stump, will then be seen to terminate free in the fibrils of connective tissue. The atrophy of the nerve keeps pace with the hypertrophy of the interstitial connective tissue. Under certain circumstances, as, for instance, in *hemiplegia*, *hydrocephalus*, &c., Rokitansky has observed the much atrophied nerves within the *cranium*, transparent, and of a greyish-red colour. According to him, the colour depends upon a gelatinous, and ultimately elastic, dense *blastema*, containing numerous *nuclei*, by which the nerve-tubes are replaced; and which is the more distinct in proportion as the amount of original *neurilemma* in the affected nerves is less considerable. The same observer also states, that the vessels entering the nerves, are, under these circumstances, often dilated.

The *ganglia*, in aged persons, together with their smaller volume, also present a relatively less quantity of ganglion-cells, whose contents also appear to contain more pigment. The preponderance of connective-tissue-fibres, renders the atrophied ganglia tougher, and the large quantity of free, yellowish-red, reddish-brown or black, granular pigment, produces an alteration of colour, obvious even to the naked eye. According to Rokitansky, atrophy of the abdominal *ganglia* occurs as a sequel of typhus fever.

communication with the nervous centres—the portion of the nerve, of whatever length, and through all its ramifications, after a certain time, becomes atrophied, the atrophy commencing, it would appear, in the distal or peripheral portions. The same takes place also when the nerve is continuous and uninjured throughout, if the portion of the brain or spinal cord to which it belongs is unable to perform its function; and from the wasting of the optic nerve, after destruction of the globe of the eye, it is obvious, that if, from whatever cause, a nerve or part of a nerve is unable or not required to fulfil its office, it will become atrophied. A fact merely showing that the nerves behave like all other tissues in the body under similar circumstances.—ED.]

The nerves and ganglion-cells of the brain and spinal cord, are, most probably, liable to the same morphological changes, but which are not there so readily perceived, since the nerves in many situations are of very minute size; and we have, as yet, discovered no suitable method of examining the brain and spinal cord in fine sections.

§ 15. The Eye.

It was formerly regarded as incomprehensible how the nutrition of the *crystalline lens* was possible without blood-vessels, but at the same time, many other tissues were forgotten —such as cartilage, hairs, *epidermis*, to which the nutritive fluid was conveyed through the intercellular passages, and to a comparatively considerable distance from the blood-vessels. Although the nutrition of the *lens* presents nothing unusual, still the relative nutritive conditions between the ciliary processes, the vitreous body, and the crystalline *lens*, are as yet quite obscure.

We believe that the greater number of *cataracts* should be referred to the category of primary atrophies, and that but few can be regarded as the consequence of an exudative infiltration.

The opacity depends upon the presence of *olein*, *cholesterin*, earthy salts, or of a fine molecular material, which, when of some thickness, presents a dirty, yellowish-brown colour. The cloudiness may be seated, either in the cortical substance of the *lens*, or in the central portion whence the three principal lines of insertion of the fibres of the *lens* spring.

Thus in the case of the cataract of an old man, the cortical substance only of the *lens* was opaque, grey, and of soft consistence, whilst the nuclear portion was of alight brownish-yellow colour, still retaining its transparency, and sharply defined, especially when viewed from the back of the *lens*; it then appeared to be surrounded by the opaque cortical substance, in the form of a broad gray ring. Viewed on the anterior aspect (fig. 35), several radiating, dark, bifurcating lines, were apparent, referable to the lines of insertion of the fibres of the *lens*, as they exist in the normal condition. The

Fig. 35.

capsule of the *lens* presented no opacity, which condition in the cortical portion depended upon a fine, molecular substance, probably precipitated albumen. There were also groups of hyaline, pale, non-nucleated globules; the fibres of the *lens* were not visible within the border of the *nucleus*, and after the cataractous *lens* was dried, could be detached in entire *lamellæ*. Nothing abnormal could be perceived in several of the ciliary processes, in the ciliary ligament, nor in the *retina*.

The greyish opacity occurring in lines, is often absent in more consistent cataracts, of a brownish-yellow colour, which retain a certain degree of transparency. Lenses in this condition frequently attain to a cartilaginous consistence, so that entire layers of the fibres may be obtained in transverse sections.

The central opacity in the case represented in fig. 36, which was that of an idiopathic cataract in a Rabbit, was limited to the central, posterior portion of the *lens*; *a* is the posterior surface, in which the dotted central part represents the opacity; *b* exhibits the lateral view, the less convex side on the right hand corresponding to the anterior surface of the *lens*, and the more convex to its posterior aspect. The opacity is seen to extend towards the front into the trifid lenticular fissure, but without reaching the anterior smaller half of the *lens*.

Fig. 36.

According to several later observers, it would appear that the question as to whether the capsule of the *lens* is involved in the opacity, must be answered in the negative. Nor have we, as yet, had any opportunity of convincing ourselves of the contrary; and deem it necessary here to notice a very obvious cause of deception with respect to this point, existing in the circumstance that an opaque material deposited upon the inner surface of the capsule, or, in more rare cases, an exudative layer on the outer surface, might be taken for an opacity in the substance of the *lens*. But closer examination soon shows that the opaque material may be removed from the surface of the capsule without injury to its integrity, the lamellar structure having lost nothing of its transparency.

We would not, however, wholly deny the possible existence of opacity in the capsule, inasmuch as it is conceivable that a partial separation of the *lamellæ* might cause an opacity of this kind.

Besides the molecular material described as existing in the cataract of the old Man, *olein* is to be considered as an element productive of opacity. This substance appears in the form of floating oily globules, which are unchanged in acids and alkalies, and are aggregated into amorphous groups, of a dark brownish-yellow colour. Scattered plates of *cholesterin* are occasionally met with, especially in the cataractous lenses of old persons.

The calcareous salts are deposited in amorphous masses, in which carbonate of lime, occasionally in a botryoidal form, appears to constitute the main ingredient (fig. 6). When these earthy concretions are treated with hydrochloric acid, a flaky substance, often of a dirty brown colour, remains as an organic residue.

It is evident that in case of defective nutrition of the *lens*, a differentiation in its normal constituents will be set up. This *primary* atrophy, which is unconnected with any considerable anatomical changes around the *lens*, becomes *secondary*, when it is accompanied by exudative processes, or new-formations in that situation, and gradually leads to partial atrophy of the globe. Professor Seidl relates, that a soldier received a wound with the point of a bayonet, at the outer margin of the *cornea*. An adherent cataract was formed, and the pupil was elongated transversely. The *lens* was diminished in size, irregular in form, and milky, and at its margin some opaque portions, with hyaline interspaces, were visible even to the naked eye. On the anterior portion of the capsule there was a grey, opaque tract, which was closely attached to the corresponding part of the *iris*, and consisted of connective-tissue-fibrils dependent from the capsule. The consistence of the *lens*, whose capsule was not opaque, was apparently softer than in the normal condition; its cells were considerably enlarged, and contained an abundant, brownish-yellow molecular material, together with opaque aggregations of granules; the *cornea* at the corresponding points was thickened, and rendered opaque by a molecular material. The cataractous *lens* in the atrophied

eye of a Horse, with *synechia posterior* (adhesion of the *iris* to the capsule of the *lens*, by bands of connective tissue), was considerably diminished in size, and contained abundance of cretaceous particles, especially in the posterior segment. The vitreous humour which had shrunk up into a convoluted mass of fine filaments, decussating at all angles, and assuming in their lengthened course arched curves, exhibited reddish-brown granular masses disposed in rows, some of which were about 0·04‴ in size. In the eyes of an old Bear, in which the atrophy was more advanced, together with a *synechia posterior*, a false membrane, composed of connective tissue, could be raised from the anterior surface of the capsule, and newly-formed vessels were also evident in the same situation (*vid. sup.*, "vessels in connective tissue"). Earthy concretions existed in the posterior portion of the *iris*, in the vitreous humour, which had, in great measure, shrunk into a fibrous substance, and especially in the posterior segment of the opaque crystalline *lens*.

The structure of the *lens* undergoes changes, both in the primary and in the secondary forms of atrophy. In very soft cataracts, the fibres of which it is composed, even when it is treated with boiling water, or hydrochloric acid, can no longer be demonstrated as in its normal, transparent condition; or, only indistinct fragments are apparent in the *nucleus*. In harder cataracts, on the other hand, these fibres are usually much more distinct than in the normal state. In very much shrunken *lenses*, a laminated cleavage of the fibres takes place. The *cornea*, when in a state of atrophy becomes opaque, and the transparent *blastema* between its layers is transformed into a fine molecular substance, or may occasionally be considerably increased, since the endosmosis and exosmosis do not go on in the normal way.[1]

We have noticed *atheromatous vessels* in the ciliary processes of an atrophied eye, and the change could be most distinctly referred to an opaque finely granular deposit on the walls. In the shrunken *retina*, an orange-yellow and red-brown pigment was deposited in considerable quantity, in large granular

[1] [The fatty degeneration of the *cornea*, described by Mr. Canton, as the proximate cause of the *arcus senilis*, should probably also be regarded as an instance of simple atrophy of that structure.—Ed.]

masses. The vessels of these processes also exhibited, here and there, coarsely granular deposits on their walls, which, when traced quite distinctly in the continuity of a vessel, presented a botryoidal, nodular aspect, whence was produced a complete net-work of earthy nodules, corresponding to the course of the vessels, and extending over a considerable space.

CHAPTER III.

3. FAMILY—HYPERTROPHIES.

THE excessive nutrition or hypertrophy of an organ, can only depend upon a multiplication of its elementary constituents, and in part on their increased volume. Unless this can be demonstrated, we are, at any rate, in a histological point of view, not justified in speaking of a hypertrophy. We are consequently acquainted with but one form of hypertrophy—the *true*, as it is termed; and regarding the so-called *false* hypertrophies, as dependent upon various pathological changes, should refer them to the appropriate family groups. The import of the word "false," moreover, implies that the condition so denominated is only an apparent one, and consequently not real. We could not, for example, regard the fatty liver as an instance of hypertrophy, since the increased bulk of the organ is due simply to the accumulation of *olein*, and because, otherwise, to be consistent, we should also describe a liver, enlarged by abscess or by cancerous deposits, as in a state of "false" hypertrophy.

As in the case of atrophies, we may, analogically, distinguish two principal causes productive of general or partial hypertrophies: 1. A hypertrophic condition of the blood (as a nutritive fluid). 2. Accelerated circulation of the blood (more rapid locomotion of the nutritive fluid).

In a theoretical point of view, it cannot be denied, that, like other tissues, so also the fluid-tissue—the blood—with its cells, may become hypertrophied, and the general *plethora* of the older writers is certainly in this sense by no means an absurdity, a view which is also supported by the hypertrophic state of general nutrition, in what is termed *polysarcia*. This general hypertrophy may localize itself in a single organ or part of an organ, when it receives a comparatively greater amount of blood, or when the nutritive faculty of the transuded *plasma* is exalted. A relatively greater afflux of blood

can only be supposed to exist in consequence of a local acceleration of the circulation, accompanied with the local dilatation of a vascular trunk. But in a hypertrophied organ the latter should not be regarded as taking place at the expense of the walls of the vessel, which are necessarily thickened in proportion to the enlargement of its calibre. In this way, the dilatation in hypertrophy is distinguished from that which takes place in congestion and inflammation. The local agents in the movement of the blood, the elasticity and contractility of a vessel, are thus augmented in hypertrophy of its walls.

It is obvious that, with a given *quantum* of nutritive fluid, the hypertrophy of one part must be accompanied with the atrophy of another. If, for instance, we suppose a large vessel, x, with two equal, smaller branches, y and z, let the quantity of the moving column of blood in x be c, and that in y and in $z = c'$. Now, if the quantity of blood in y be increased in the hypertrophy of the vessel, and that in x remain stationary, some must be abstracted from c', in the vessel z. Consequently, there will, in this case, be produced an *asymmetry* of nutrition, which is frequently met with. We need merely notice the unequal size of the double organs, without change of texture, and the varied bulk of the right and left halves of the single.

It has been stated above, that in hypertrophy, the type of nutrition appropriate to the organ will be retained, that is to say, a multiplication of its proper morphological elements must take place. But this does not prevent the occurrence of anomalous conditions of nutrition in the hypertrophied parts, which ultimately, very frequently fall into a state of involution. The morphological changes which the hypertrophied organ undergoes, under these circumstances, are precisely analogous to those which accompany involution in general.

The *special conditions* of the hypertrophied organs will render the process more manifest. We will commence at once with the hypertrophy which occurs most frequently—that, namely, of the *adipose tissue*.

It is well known that the female sex is very prone to an increase of the fat-cells, which ultimately becomes so great that the action of the muscles is interfered with, in consequence of v ·eneral nutrition is impeded. In men, this dispo-

sition to the accumulation of fat is often observed in the second period of life. In infants at the breast, Engel has remarked that the consequence of the hypertrophy of the adipose tissue is an impoverishment of the blood, which frequently causes death rapidly and unsuspectedly. In persons addicted to the use of alcoholic drinks, he describes the hypertrophied fat as altered in quality—being soft, unctuous, of a greyish-white colour and mawkish smell; and in persons who have been successfully cured of secondary syphilis, the fat, not unfrequently, presents similar characters. He also states that, in cancerous deposits, particularly in the skin and subcutaneous cellular tissue, abundant deposits of firm, granular, deep-yellow fat also take place. With respect to the more intimate conditions of the growth of fat, consequent upon the copious use of non-nitrogenous food, as well as with respect to the chemical variations of the hypertrophied fat in general, researches are still wanting. The various forms of *lipoma* have always been regarded as local hypertrophies of the adipose tissue.

In the *epidermis*, some forms of hypertrophies are very frequently met with. Callosities, consisting, as is well known, simply in a thickening of the *epidermis*, originate in an often repeated or continued pressure on the skin, the irritation caused by which produces an exalted productivity in the epidermic cells and in those of the horny layer. The thickened epidermis often becomes dry and fissured. Perpendicular sections show that the cells are disposed in a different direction to the natural one, and that the ducts of the sudoriparous glands are dilated and cleft. The border of a callosity is, usually, not very sharply defined, being gradually lost in the surrounding *epidermis*. According to G. Simon, the *corium* beneath the callosity always retains its usual thickness, and is otherwise of normal structure. The only change which he has occasionally perceived in it, consists in a greater fulness of the blood-vessels than exists in the neighbouring skin. This greater abundance of blood in the *corium* also appears to us to be the reason why we occasionally meet with callosities which are so moist throughout as to present the consistence of caoutchouc.

From callosities are formed "*corns.*" These are circumscribed hypertrophies either of the horny or mucous layer of the *epidermis*. In the formation of these growths there may be ob-

served, inserted as it were in the callosity, a horny *lamina*, in which the cells, instead of their being disposed chiefly in a horizontal direction, assume one more approaching the perpendicular, and continuing to grow in this direction, eventually constitute a conical elongation of the horny layer projecting beyond the level of the callosity. Like the horny, the mucous layer is also hypertrophied in the form of a hollow cone inserted into the *cutis*. Occasionally, two such depressions of the mucous layer are met with, and perhaps several may occur together. In fine perpendicular sections, it will be satisfactorily seen that the papillary layer at the infundibuliform depression, sometimes 0 88‴ long, is, as it were, displaced; and an injected state of the vessels in the cutis is visible, even to the naked eye, in vertical sections. The hypertrophied mucous and horny layers of the *clavus* consist of cells forming transparent *laminæ*, as in the normal *epidermis*, but which are so closely united that, unlike the latter, they do not swell up on the addition of water. In horizontal sections of the *clavus*, a lighter coloured central substance may usually be recognized, the so-termed *nucleus*, which is surrounded by concentric *laminæ*, and presents a firm consistence. The primary rudiment of the *nucleus* appears to be derived from the mucous layer of the skin. Its cells are placed more or less obliquely, as may be demonstrated in fine transverse sections treated with acetic acid.

The more deeply the *clavus* penetrates into the *cutis*, the greater will be the irritation produced in the latter, even after the cessation of the external pressure. Secondary exudations may also take place in the subcutaneous tissue or even in the more deeply seated parts, since, moreover, the part of the corium displaced as it were by the *clavus*, becomes atrophied. G. Simon has occasionally found minute extravasations of blood in the substance of the *corium* or on its surface. He has sometimes also remarked among the epidermic cells composing the *clavus*, small dry *coagula*, which he thinks had been raised from the surface of the *corium* by the growth of the *epidermis*. He altogether denies the frequently asserted participation of the synovial follicles of the skin—its synovial sacs, as they are termed—in the formation of corns, admitting only the possibility of a secondary inflammation of the sac. Bärensprung

states that an abnormal synovial sac between the *cutis* and the tendon of the *extensor digiti*, is formed simultaneously and in connexion with the corn, a statement which receives no support from our own observations.

Horn-like growths of the skin are to be regarded as arising from the hypertrophied horny layer of the epidermis, in which the cells are as much flattened and as closely applied to each other as they are, for instance, in the nail, and are characterised by their being multiplied in a longitudinal direction. These cuticular horns, as is well known, have been met with, seated not only on the *epidermis*, but also on the inner surface of a sebaceous tumour.

The deformity sometimes witnessed in the *nails*, consisting especially in an increased thickness and the formation of step-like layers with diminished transparency, or in which some of the layers take on a different direction in their growth, is to be referred to the category of hypertrophies of the cornified *epidermis*.

The hypertrophy of isolated, circumscribed groups of *papillæ* of the *corium*, is frequently seen in the well-known form of *warts*. But these growths, together with *condylomata*, will be more particularly noticed when we come to speak of the new-formations of connective tissue.

We think, however, that the dark-coloured, wart-like *nævi materni* should be here adduced as an instance of hypertrophy of the papillary part of the skin. At a distance of some inches from the nipple of a woman, there was situated a dark-brown warty excrescence, elevated above the surface of the skin, and about half an inch in diameter. The cells of the mucous layer of the *epidermis* presented in several places, especially on the points of the *papillæ*, *nuclei* covered with dark brown pigment (fig. 37, *a*), which in other parts (*b*) were

Fig. 37.

only partially enveloped by it; the epidermic cells for the most part contained no pigment (*c*). The *papillæ* were considerably larger than in the normal condition, the increase being chiefly in their thickness. They contained in parts a black, and in parts a reddish-brown pigment, which did not appear to be enclosed in cells (*d*). The scattered nucleiform bodies (*e*) were more distinct after the action of acetic acid, and belonged to immature connective tissue in a state of development. In several large *papillæ*, vascular loops, such as are shown in *f*, might be seen. Another warty *nævus*, of the same kind, contained, in its much hypertrophied, subglobose *papillæ*, abundance of reddish-brown pigment, manifestly deposited in the substance of the *papillæ*, and not at all in the *epidermis*. There were also, numerous immature, flattened, roundish elements of connective tissue, most of which were in a state of fatty degeneration.

Among the more extensive hypertrophies of the *epidermis*, according to most observers, should be reckoned *ichthyosis*, or the "fish-skin disease," in which G. Simon found the superficial layers of the *epidermis* firmer and browner than the deeper, which were of a whitish colour. The *cutis* also was somewhat thickened, and presented very large *papillæ*, obvious even to the naked eye. In most parts of the skin, he noticed hair-follicles with the hair, from the orifices of which he could express a substance resembling the cutaneous sebaceous matter. The sebaceous follicles could no longer be distinctly recognized, although they appeared still to exist. Foreign elements could not be detected in the normal cuticle.

Elephantiasis arabum has been regarded by many as a hypertrophy of the *cutis* and of the subcutaneous tissue. In certain respects this is correct, but the disease is not limited to these tissues, always extending to the subjacent organs. The adipose, muscular, and osseous tissues, undergo essential changes, which appertain to the characters of fully developed *elephantiasis*, and which, consequently, we deem it more convenient to discuss in speaking of "new-formations of connective tissue." Hypertrophies of the *connective tissue*, owing to the extensive distribution of that structure in the organism, are of very frequent occurrence, although in certain cases it is extremely difficult to classify them as such. If we take, for instance, a mammary

gland, whose proper parenchyma is in an atrophied condition, on dissection, the connective tissue will be found remaining, *minus* the glandular tissue, although we should not thence be induced erroneously to describe this apparent hypertrophy of the preponderating connective tissue as being really such. But in many cases where the atrophy is less advanced, as, for instance, in thickening of the capsule of Glisson in the liver, it is still to be determined whether there may not, at the same time, also exist a hypertrophy of the connective tissue. This can be decided in an anatomical way, only from the preponderance of that tissue, without any considerable, or even any actually increased bulk of the organ.

It is yet more difficult to determine the *limits between hypertrophies and new-formations of connective tissue.* If we consider, for instance, the case of a granular liver, it might be referred to hypertrophies of the interstitial connective tissue, or to a new-formation of that tissue, or even be classed in the category of atrophies, because the proper hepatic *parenchyma* is gradually removed. Here we must be guided by the consideration of the mode in which the process is developed, which, from the considerable amount of immature connective-tissue-elements, fibre-cells, &c., is wholly opposed to the notion of a simple atrophy. Between hypertrophy and a new-formation of connective tissue the choice would fall upon the latter, since the character of the interstitial connective tissue is gradually lost. Nevertheless, it is apparent, at the same time, that we should thus be attempting to set up ingenious distinctions where none exist in nature. For in pathological formations of connective tissue in general a double process is conceivable. In one case there will be merely an increased multiplication of the existing cells, and in the other, a new-formation of connective tissue, as in the embryonic condition, will take place. Hence it is clearly impossible to decide where the one ceases and the other begins.

The same subtle distinctions occur in the *hypertrophies of bone.* Among these must be enumerated that increase of the bulk or of the density of the osseous tissue, termed by Lobstein *osteosclerosis,* in which the bones, besides their increased bulk, are rendered so much harder and more compact throughout, that their specific gravity is greater than in the normal condition. In this case there is a multiplication of the systems of bone-corpuscles

around the medullary canals and *cancelli*, at the expense, in fact, of those cavities. A bone in this condition appears more dense, and consequently has lost some of its porosity. The bone-corpuscles appear also to contain calcareous salts, and are more opaque than usual.

Authors are not agreed as to the mode in which *osteosclerosis* is produced. Van der Haar has assumed that inflammation takes place in the spongy tissue of the bone itself, in consequence of which the cells are said to be at first enlarged, in order afterwards to be filled with a hard, osseous substance, resembling ivory or stag's horn; whilst Lobstein, on the contrary, thinks that no inflammatory process is requisite for the development of this homöoplastic substance. According to Rokitansky the affection is not preceded nor induced by any structural disease of the existing bone, which itself presents an even, smooth surface, a normal *periosteum*; and, even in *sclerosis* attended with great eburneous density and hardness, the texture of the bone is in other respects normal. In other cases he regards the increased bulk of the bone as an external or internal *sclerosis*, dependent upon an inflammatory process, attacking sometimes the outer layers of the bone and the *periosteum*, sometimes seated in the deeper capillary system of the bone, or sometimes, lastly, in the medullary membrane. In the majority of cases these distinctions are blended, inasmuch as in some places a hypertrophy of the osseous tissue, in others an involution, or even a partial fusion of the hypertrophied tissue, is set up.

Considering the foregoing facts, it is again evident that, in this case also, we must admit a transition of the *transudation* destined for the nutrition of the bone, into an *exudation* (organizable *blastema*), whence the passage from hypertrophy into new-formation of the bone cannot be defined.

Hypertrophy of the *striped muscular fibre* is usually studied in hypertrophied hearts, with respect to which we would make the preliminary remark, that, except in a few cases, hearts so diseased are presented for observation at a stage when the hypertrophied parts have already, here and there, entered into a state of retrograde metamorphosis. The colour of the muscular substance is usually tawny, often of a rusty brown; its consistence sometimes so much diminished as to admit of its

being separated with as much ease as if it had been soddened; sometimes more tough, as if the fibres were glued together with a more tenacious substance. Occasionally, even, a remarkable succulence is observable in many places.

In proceeding to the elementary investigation, it is requisite to place portions of the altered tissue upon a dark ground, and carefully to tear them to pieces with two needles, which is better done under a simple lens. Primitive *fasciculi* are not unfrequently met with, exceeding in width those usually existing in the heart; they may attain a diameter of 0·026—0·030‴. Dichotomous divisions are to be sought for especially in newly formed *trabeculæ* and hypertrophied papillary muscles. Fig. 38, *a*, is a primitive *fasciculus* thus dividing, towards the surface of which, groups of dirty yellow pigment-molecules, disposed parallel to the longitudinal axis, and which remain unaltered in acetic acid and diluted alkalies, are visible; they are very probably deposited around the *nucleus* of the *sarcolemma*. Kölliker has noticed these molecules, especially in atrophied muscles, in a state of fatty degeneration, or otherwise morbidly affected. In any case, they represent a form of involution. If these dichotomous divisions are traced further, we come upon slenderer branches (*b*). Anastomosing muscular fibres often appear, either in the form, *c*, in which the branches given off from two *fasciculi* unite at an acute angle into a single fibre, or in the more simple one, where an oblique communicating branch connects two fibres.

Fig. 38.

Besides this hypertrophied muscular tissue, often in a state of involution, and which, as is well known, is not unfrequently in a condition of fatty degeneration in the *trabeculæ* or papillary muscles, an abundance of fat or of pigment-molecules is occasionally met with deposited in the interstitial tissue; in which, also, laminated colloid bodies (*d*), or some simply of a flat or rounded form, are apparent.

In the more succulent portions, the muscular fibres appear to be pervaded by a gelatinous matter, and the *striæ* are rendered indistinct, whilst transverse enlargements make their appearance (fig. 129, *c*).

In order to obtain an idea of the transverse diameter of the muscular fibres, and their relations to the surrounding flaky, fatty, pigmented substance, it is necessary to prepare transverse sections. This may be done, either by means of the double knife in the moist muscle, or, when it is dry, by means of a single-bladed scalpel. But, in doing this, it is requisite to pay particular attention to the course of the fibres, for otherwise we shall obtain nothing but oblique sections.

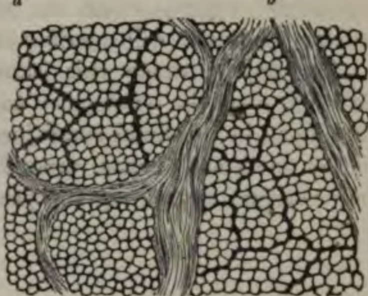
A question, in the investigation of these hypertrophied muscles, still remains: as to the possibility of showing the existence of embryonic muscular fibres, such as are found in very young embryos, and have been figured by Schwann. The increased transverse diameter of the muscular fibres is to be regarded simply as an ascertained fact. This is, doubtless, due to a multiplication of the primitive fibrils, as is manifest in embryos, in which it can be readily shown, that, with the advancing age of the *fœtus*, the number of primitive fibrils increases. In the muscular fibres of very young embryos, we find not more than three or four primitive fibrils, whilst, in those further advanced, that number is sometimes more than doubled.

As in the case of the striped muscles the hypertrophy is limited only to certain portions, so also in the *organic muscular fibres* it is only partial. The change is recognizable, even by the naked eye, by the pale-red fibrillation. C. Bruch was the first to give a precise description of the hypertrophy which occurs in the pyloric portion of the stomach. According to our observations, this growth often attains to the thickness of an inch or more, usually diminishing towards the *pylorus*, and arising chiefly in an increase of the circular fibres. The areolated aspect of the hypertrophied muscular coat is caused by the deposition in its texture of connective tissue, which surrounds, as with a sheath, entire groups of organic muscular fibres, and increases in thickness towards the sub-mucous tissue, so that the muscular layer runs out into fine teeth, the interspaces between which are occupied by the connective tissue. The pale-red stripes are easily split up in the direction of their

length, exhibiting, under the microscope, elongated ligamentous fibre-cells, which, in their size, and the conformation of their *nucleus*, present more considerable diversity than is usually observed in them in the normal condition. In certain layers of the muscular tunic, flattened cells, also are met with, not unlike epithelial cells, but differing from them principally in their having an oblong *nucleus*. These cells, which are also of various forms and sizes, constitute a layer which is in apposition with the fully developed organic muscular *fasciculi*, and probably represent their embryonic forms. The white dissepiments between the layers of the organic muscular fibres are bundles of connective tissue.

In order to study the secondary arrangement in transverse sections, a portion of the hypertrophied muscle which has been boiled in acetic acid and dried should be employed. In the transverse section, the bundles of organic muscular fibres (fig. 39) appear as groups of minute polygonal corpuscles, which seem to be surrounded by sheaths composed of undulating bundles of connective tissue.

Fig. 39.



The submucous tissue, at the same time, is never in a normal condition, being either thickened or infiltrated with a gelatinous substance.

The occurrence of muscular hypertrophies in general, is regarded as consecutive to a previous inflammatory process, which, partly by ulceration, partly by infiltration, produces a contraction of the intestinal canal or a hinderance to the closure of the cardiac valves. The connexion of partial hypertrophies in the organic muscular fibres with the corresponding inflammatory processes in various parts, has been shown by Engel. But in hypertrophy of the muscular substance of the heart, he was unable, in many cases, to discover any anatomical indication of a mechanical impediment to the motion of the blood; it appearing to him, that an increased afflux of a *liquor sanguinis*, abounding in plastic elements, was sufficient for the production of the

hypertrophy. The reality of a substantive or primary hypertrophy cannot be called in question.

The *blood-vascular*, and especially the *lymphatic glands*, often present a considerable increase of bulk without any perceptible structural change. The only anatomical characters exhibited, consisting in a considerable accumulation of *nuclei*, particularly in the latter class of glands, which, under these circumstances, afford a more or less turbid fluid when squeezed. In the spleen, all that is usually observed is an abundance of the usual elements, without any foreign admixture. But in these cases we are still at fault for suitable methods of investigation.

The *true glands furnished with an excretory duct* are also liable to hypertrophy, when, of course, the increased volume depends upon an increase of the proper glandular parenchyma. In these cases, we must assume a new formation of the glandular lobules, which, as a pathological phenomenon in the larger glandular organs,—such as the lungs, liver, kidneys, and salivary glands,—will manifest itself only in parts of the organ.

The way in which this increase of glandular substance is effected, must be analogous to that according to which it is developed in the fœtal condition. New terminal ramifications of the ducts are formed, around which are deposited groups of new vesicles, containing the proper gland-cells.

CHAPTER IV.

4. FAMILY—EXUDATIONS.

THE most prominent act attending inflammation consists in the increased transudation of the blood *plasma*, through the uninjured walls of the vessels of an organ. The product of this "exudatory" process is termed an "exudation," the general character of which resides in its being a material containing protein, which sometimes, from the preponderance of the aqueous constituent, retains the fluid form, and sometimes passes partially into the solid state. The latter metamorphosis of the exudation, again, may either ensue at once, as it would do were the fluid without the organism,—that is to say, the *fibrin* coagulates, and the albumen and salts are precipitated,—or the elements undergo changes under the vital influence, which are comprehended under the term "organization of an exudation." Elementary organs are formed from the exudation, which constitute the new-formations.

In this Family we have to do with the exudations in the special organs, only so long as they have not undergone any organic development. Moreover, in this case also, it is impossible to keep within precise limits, inasmuch as gradual transitions exist, into the self-organizing exudations, which would be more appropriately termed "incipient new formations."

§ 1. SEROUS MEMBRANES.

We shall commence with the exudations in the serous cavities, as being those in which many of the morphological conditions are clearly exhibited. In the first place, we would notice a form of fibrinous exudation frequently observed under the aspect of a velvety deposit on the visceral surface of the *pericardium*, in *pericarditis*. This exudation has a yellowish or a more or less marked, yellowish-red colour, which is deeper in the thicker portions. To the naked eye, the deposit presents an

interlaced, felt-like appearance; the delicate, indistinctly defined, and intertwined filaments, are better traced under the simple microscope after the blood has been removed by washing. Its consistence is loose, and fragments are readily broken off with the *forceps*, or even entire layers may be detached from the *pericardium*. The divisibility of this coagulated exudation may be also readily perceived from the ease with which it may be more minutely broken up by means of needles. When its physical properties are more closely investigated, under a higher magnifying power, it is seen (fig. 40) to consist of a very delicate net-work of short, undulating, interlaced filaments, which cannot be drawn out to any length, and are never collected into bundles. These latter, negative characters are particularly to be attended to, as they indicate an essential distinction between the fibrils in question, and the bundles of connective-tissue. The filaments do not, in general, differ materially in thickness, although some occur of immeasurable tenuity, and which are not apparent until the illumination is modified. But this delicate mesh-work, as is shown in the figure, exhibits sometimes rounded, sometimes elongated spaces, which appear to contain, in part at least, only a hyaline fluid. The filaments disappear under the action of acetic acid and of alkalies, being replaced by a gelatinous *coagulum*.

FIG. 40.

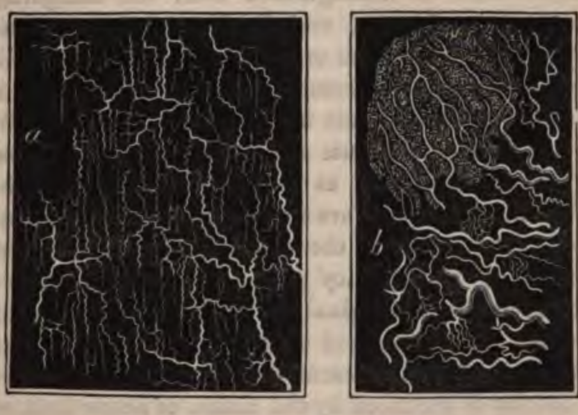
If the constitution of this exudation be compared with the coagulated fibrin of the blood, no morphological difference between the two will be discerned (*vid.* "coagulated fibrin," p. 35), and as they also agree in their reaction with acetic acid and alkalies, the former must be regarded as coagulated *fibrin*.

In pericardial exudations of this kind, however, other new-formations, such as blood-corpuscles, rounded cells with large *nuclei*, scattered *nuclei*, &c., usually occur, which are manifestly lodged in the interstices of the fibrous frame-work, and by which the exudation is gradually metamorphosed into a new-formation. We shall not here advert further to this, carefully

remarking, however, the circumstance that the coagulated *fibrin* presents an areolar arrangement. The question whether coagulation really take place during life admits of no doubt, from observations made in animals, immediately after death, which show that fibrin does coagulate during life.

If the serous membrane be closely examined after the exudation has been removed, streaks of very delicate *vascular injection* will be observed, which may also be interrupted by diffused bloody points. These points occur frequently, and represent minute extravasations of blood, and, like the injected vessels themselves, are seated in the subserous tissue. The red tracts seen in *peritonitis* afford a beautiful instance of vascular injection of the subserous tissue. They are due principally to blood-stases in the vessels of the organic muscular layers. The vascular twigs (fig. 41, *a*), in their ob-

FIG. 41.



liquely ascending course, give off transverse branches which subdivide into longitudinal capillaries, whose terminal anastomosing ramuscules are not distinctly apparent. The curling course, the parallel direction, and the circumstance that the branches are given off at right angles, afford sufficient evidence that these vessels belong to the longitudinal layer of organic muscle of the intestine. But the injection of the vessels may usually be noticed also in the annular muscular layer, and in the submucous cellular tissue of the intestine. The larger vessels of the adipose layer (fig. 41, above *b*), as well as the

much convoluted large vessels of the submucous tissue, which occasionally terminate in an injected capillary *plexus*, are also filled with blood.

Rokitansky has remarked, that the degree of redness, and injection of a serous membrane, compared with the amount of the inflammatory product, by no means affords any general measure of the intensity of the process, inasmuch as the one, especially in inflammation of a croupose character, is remarkably disproportionate to the other. This can only be explained upon the supposition that in rapid exudations, mainly of a fibrinous nature, a transudation of the red colouring matter contained in the blood-corpuscles also takes place, by which the vessels are rendered inapparent. Otherwise we should be obliged to suppose that a transudation of the *fibrin* may occur independently of any *stasis* of the red blood-corpuscles.

Another form of exudation, also accompanied with phenomena of an acute kind, is distinguished from the foregoing by a larger proportion of water, and by its *gelatinous consistence*. This exudation, in the form of a more or less viscid fluid, pervades the subserous and serous tissues, widely separating the fibrinous *fasciculi* and elastic fibres. Care must, therefore, be taken not to regard the elastic and connective tissues presented under these circumstances as of new-formation. Embryonic forms of the latter, however, are common, and will be subsequently described. The colour of the exudation is more or less deep yellow, and the transparency perfect, for the cloudiness of the parts is due solely to the original and newly-formed morphological constituents. It is rendered opaque by boiling, exhibiting a fine molecular substance, resembling precipitated albumen. A streaky opacity is produced by the action of acetic acid, exactly as in *sputa* containing *mucin*. When the exudation is more viscid, the serous and subserous tissues infiltrated with it, do not collapse when a small portion is cut off with the scissors, and punctured with the needle. But when it is more watery, and the effusion of a more serous nature, the escape of the thin fluid, under the above circumstances, causes the infiltrated tissue to collapse.

Thin, varnish-like coatings occur on the free surface of serous membranes, which are very viscous, transparent and sticky. The more intimate characters of these effusions have

not as yet been investigated. They are not improbably allied to *colloid exudations*, which, when poured out in considerable quantity, sometimes pass into the solid condition, and assume the aspect of greyish-white nodules. A soft, pleural false-membrane, about 1·76‴ thick, consisted chiefly of ligamentous layers in the more consistent portions, which resembled very much softened cartilage. Between the layers (fig. 42), there

Fig. 42.

was deposited much free *olein* in the form of minute globules, which were rendered more distinct upon the addition of alkalies, and remained unaltered in diluted acids; the latter, however, caused the evolution of a few air-bubbles (carbonic acid). Groups of more or less irregular, cholesterin-plates occurred here and there. Towards the inner surface of the thickened costal pleura the layers were considerably softer, and formed a pultaceous substance; they were constituted of irregular, hyaline, soft plates, like finely divided size. They were not changed by the action of acetic acid.

In layers of exudation of a *cartilaginous consistence*, such as frequently occur likewise on the costal pleura, these apparently fibrous layers also constitute the main elements, and must not be confounded with the bundles of connective tissue; when the latter are present, with immature cells, they are entirely subordinate to the tabular layers. In many parts fat is accumulated in considerable quantity; and these parts are distinguished by their yellow colour. We regard these condensed exudations as arising in colloid-effusions.

Cretified exudationsof the serous membranes present the aspect of osseous plates, although to careful examination, even by the naked eye, they usually appear like indistinct white spots, which, so far as we have had an opportunity of observing, never possess the essential character of bone, viz., the bone-corpuscles. We have observed only deposits of calcareous salts in a botry-

oidal form (fig. 43, *a*), which are also sometimes met with of much smaller dimensions (*b*).

FIG. 43.

They are always grouped together; and the substance in which the groups are lodged is marked with transparent streaks, and occasionally presents, parallel with these, elongated opaque *striæ* of tolerably uniform breadth, which may also be seen to bifurcate (*c*, *c*); between them may be perceived dark fissures or vacuities, which it is improper to regard as imperfectly formed bone-corpuscles, since no intermediate forms between them and perfect bone-corpuscles can anywhere be perceived (*vid.* incomplete ossification of a fibroid tumour in the *uterus*, fig. 38). We look upon them as dried, gaseous cavities; whilst *c*, *c*, may be obliterated blood-canals.

We consider the condensed and cretified, colloid exudations on the serous membranes, as *forms in a state of involution*, and consequently as no longer capable of any organic development.

In the same condition, also, are to be regarded the *local opacities* of the serous membranes, as, for instance, the so-termed "tendinous" or "white-spots" on the *pericardium*, of which Rokitansky describes two kinds. He distinguishes the *adherent patches*, which can be raised from the surface, and removed, exposing a tolerably normal pericardium,—that is to say, the surface of which is not perfectly smooth, and the texture condensed, and occasionally perceptibly clouded,—from many other kinds of usually diffuse opacities of that membrane, consisting in an inconsiderable hypertrophy, or a trifling thickening and condensation of the serous investment. According to our notion of hypertrophy, as stated above, the latter form cannot be regarded as belonging to the same category. The free surface of serous membranes presenting this kind of diffuse opacity, is smooth, and even; if the opaque spots are removed, and the attached surface be examined, the opacity will usually

be found to reside solely in a brownish-yellow, molecular material; the increased bulk of the tissue of the serous membrane, is therefore only apparent. In rare instances a new formation of connective-tissue is the cause of the opacity, but in this case the free surface of the membrane is rendered uneven, and presents nodular elevations. The opaque spots having a molecular aspect, appear to depend upon albuminous exudations in the subserous tissue.

The *dropsical exudations* of the serous membranes, which, owing to the great proportion of water they contain, are unorganizable, present, as such, no morphological elements; it is not until the albumen, in a state of solution, is precipitated, that a fine molecular material makes its appearance; or when a drop of the watery exudation is subjected to spontaneous evaporation, dendritic crystalline forms may be observed in it.

It is beyond all doubt that the dropsical exudation may arise with very great rapidity in the serous membranes. On this subject Lobstein instituted decisive experiments in several young animals, just born. When, by the application of galvanism, he excited the movements of the heart, he was enabled to remark, that, as he continued his experiment, an effusion of fluid beneath the very transparent *pericardium* of these creatures took place before his eyes, and that the amount of the fluid poured out was in proportion to the duration of the experiment. He thence came to the conclusion that the presence of water in the *pericardium* is due to the death-struggle, and the contractions which take place for a short time after death.

The organizable exudations of the serous membranes give rise principally to the formation of pus, cellular tissue, blood, and blood-vessels. We have already stated that we do not recognize a purulent exudation, since the pus-corpuscles do not transude as such, but are a new-formation. Nor can we regard hemorrhagic exudations in the serous membranes as of a special kind. An exudation, complicated with hemorrhages, of a serous membrane, would only be conceivable as a consequence of its laceration. The usual hemorrhages which are connected with chronic exudatory processes, proceed from the newly formed blood-vessels on the inner surface of the serous

sac, and on this account also cannot justify the institution of a distinct species of exudation.

It is obvious from what has been already stated, that the exudatory process is not limited to the serous tissues alone, but also involves the subserous. The nutritive and motile phenomena, consequently, of the affected organ, will be the more interfered with, the more deeply the process extends beneath the serous membrane. For instance, a subperitoneal exudation in the intestine will injuriously affect the contractility of the organic muscular coat, and thus impede the peristaltic movement. If the exudation do not admit of being absorbed, the pigment and molecular, flaky or fibrous, &c., substances are left, which, being in a state of involution, induce a more or less extensive atrophy of the tissue originally infiltrated with the exudation. In the case, for instance, of an exudation in the subserous, fibrous tissue of the synovial membrane of a joint—it is easy to perceive that the motility of the articulation must necessarily, even after absorption has taken place, be affected in proportion to the extent to which the infiltration of a thick fluid exudation has taken place in the surrounding ligamentous structures.

§ 2. External integuments.

Exudations in this situation are particularly fitted for study, being accessible to observation even during life. The most frequent are those which take place in the cutaneous *papillæ*, in which they are either confined to small limited districts, within which the exudation takes place around isolated groups of *papillæ*, or are more extensive. An instance of the former kind, or of a limited exudation, is afforded in smallpox, in which the spots are at first filled with a limpid fluid, containing nothing but molecules, and do not become true pustules till afterwards, when pus-corpuscles are developed in the hyaline exudation. The transudation takes place from the capillary system of the *papilla*, the exudation as it is poured out gradually accumulating between the under surface of the *epidermis*, and the upper surface of the *corium*. But since the process is confined to limited groups of *papillæ*, the *epidermis* covering the latter is raised in the form of a transparent vesicle, whilst the spot at which the hair escapes from its sheath, together with

the excretory duct of the sebaceous follicle, remains depressed, and constitutes the central *pit* of the vesicle. In those parts of the skin where no hairs nor sebaceous follicles exist, as in the palm of the hand and sole of the foot, the exudation deposited around a point where several of the deeper grooves in the *corium* meet, may cause a similar pit, since in a situation of this kind, the *epidermis* constitutes a stronger layer, and is of closer texture. When the puriform fluid in the pustules begins to dry up, the pit becomes shallower and wider, owing to the subsidence of the swelling. In the integument of a subject dead of smallpox, it is easy to perceive that the vessels of the *papillæ* are more or less injected, when the skin has been macerated long enough to allow of the removal of the *epidermis*, beneath which the isolated patches of vascular injection are immediately apparent. Perpendicular sections show that the *papillæ* are the constant and principal seat of the injection; and it is from their vessels also that the hemorrhage takes place, in cases of petechial smallpox. Fig. 44 represents a perpendicular section of variolous integument, from the upper part of the thigh of a boy, who died on the third day after the appearance of the eruption, from exhausting bloody diarrhœa. The eruption was confluent, the vesicles were collapsed, and in several places, especially on the abdomen, changed into brownish-black crusts. The hemorrhagic effusions were mostly confined to the papillary stratum, rarely penetrating more deeply into the substance of the *corium*, but never so deeply as the bulb of the hairs, in the immediate neighbourhood of which, as well as elsewhere, the *cutis* was uninjected. *a*, *b*, represent the papillary *stratum*, after removal of the cuticle; the darkly shaded parts below the apices of the *papillæ*, represent the minute extravasations, and the partial vascular injections; *c*, opaque epidermis; *d*, thin transparent layer of exudation between the *epidermis* and *corium*; *e*, under part of the *corium*; *f*, adipose tissue; *g*, hair-bulb, surrounded with fat-cells.

FIG. 44.

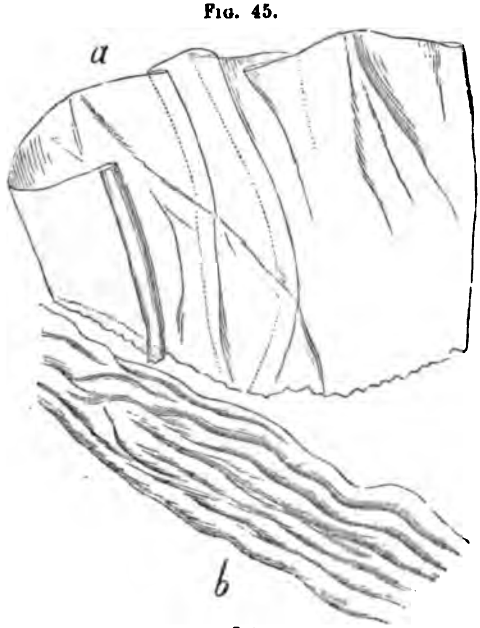
The *epidermis* becomes, as it were, digested in the fluid exudation, and exhibits, when removed and viewed from beneath, the areolated aspect proper to it in the normal condition. The little ridges upon it correspond to the depressions of the *cutis*, and the elevations of the latter fit into the sinuous hollows of the cuticle. If isolated portions of the *epidermis* are examined, the cells will be found to be rendered opaque by a molecular material. The substance resembling a soft, false membrane, which is easily removed, partly from the upper surface of the *cutis*, and in part from the under surface of the cuticle, consists solely of young epidermis cells, and of a molecular substance, often containing sanguineous clots. G. Simon, whose observations upon this subject agree with our own, has remarked, that the soft, white layer should by no means be described as a false membrane, as it is by Rayer, since it is mainly constituted of epidermic elements, and because it cannot be confounded with a coagulated protein-substance.

Upon the whole, it appears clear, in the case of *variola*, that exudative processes may be limited to very circumscribed spots, that is to say, that the exudation may take place around a group of capillary vessels, whilst the contiguous groups are not the seat of any transudation. This phenomenon can only arise from the anatomical distribution of the vessels. It is well known that an arterial branch supplies a group of from twenty to thirty (or more) papillary loops, which pour their blood into a common venous ramuscule. Now, when these vessels, in cases of impeded circulation, are filled with blood, the entire group of injected *papillæ* will present the appearance of a single, minute red point; and if the disturbance of the circulation involve contiguous papillary groups, a red spot will be produced, such as may be noticed in the lower extremities, even in the dead subject, in cases of *variola*. From exudations in the groups of *papillæ*, arise very minute vesicles, which by reiterated transudations, coalesce, and form a single, larger vesicle, containing, as stated above, a limpid fluid. The morphological changes undergone by this fluid will be afterwards noticed.

When a considerable quantity of fluid exudation is collected at one spot on the surface of the *cutis*, the *epidermis* will be

raised in the form of a vesicle, as in *pemphigus*. The process of formation of this kind of vesicle can be traced after the application of a blister, and confirmation will thus be afforded of what G. Simon has stated with respect to it. According to his observations, minute vesicles arise, in consequence of the detachment of the *epidermis*, at isolated points, by an exudation collected under it, which vesicles gradually enlarge, coalesce, and constitute a single, larger vesicle. If this formation of vesicles take place on a part of the body in which the hair-follicles are placed widely apart, he has occasionally noticed that the *epidermis*, at the points where the hairs project from the skin, retains its connexion with the *corium*, for a longer time than in the intermediate spaces. The surface of the vesicles thus formed, on which the openings of several hair-follicles are always to be seen, then exhibits depressions around these orifices, and elevations in the intervening spaces, owing to the circumstance that the hair-follicles being connected with the cuticle, prevent its being raised. When the collection of fluid is greater, however, the hair-follicles give way, and the *epidermis* is elevated uniformly. If the under surface of the detached *epidermis* be examined, numerous minute appendages will also, often be noticed, which are the upper portions of the hair-follicles. A similar appearance is presented in *pemphigus*.

FIG. 45.



The contents of the vesicles in this disease are at first transparent and clear, and of a yellowish colour; and at this time no elementary constituents whatever can be discerned, or such only as are in a state of incipient for-

mation. If the clear fluid be heated, a finely flocculent cloudiness is produced, caused by the precipitation of albuminous molecules. Sometimes a deposit may be noticed (fig. 45), in the form of a membrane, plicated like a structureless tunic (as for instance, the capsule of the lens) (*a*), which extends over a considerable surface, or is thrown into folds like a drawn curtain. This substance is unaffected by acetic acid. Whether it be of a colloid nature, must be ascertained by more precise investigation. When the contents of the vesicle have become opaque, numerous pus-corpuscles will be found in it. Not unfrequently, also, minute extravasations of blood take place from the surface of the *cutis*, and redden the contents of the vesicle.

The *epidermis*, which is separated from the parent surface by the layer of exudation poured out beneath it, necessarily dies and is thrown off, to be subsequently replaced by a new *epidermis*. In many skin-diseases, the *exudations in the papillæ* of the corium are so scanty at each spot, that the *epidermis* is merely raised in the form of a diminutive vesicle, as in *miliaria*, *eczema*, *herpes*, &c.; but occasionally several of such vesicles will coalesce. The exudation, which is poured out in small quantity, sometimes appears to thicken, owing to the greater proportionate amount of protein-substances which it contains, as the watery constituent evaporates, producing more consistent papular elevations, as in *measles*, *lichen*, and *prurigo*.

Our investigations of the *papulæ* of the last-named disease have shown that the larger ones are frequently filled with a yellowish fluid, and several hairs may be observed seated upon one *papula*. Occasionally, with a strong lens, numerous groups of red points, at uniform distances apart, may be observed towards one or other side of the larger as well as of the smaller *papulæ*, manifestly corresponding to the injected vascular loops of the *papillæ*. *Papulæ*, tinged with blood, are also occasionally met with, most probably produced artificially by scratching. The smaller sort are furnished only with a single central hair. Perpendicular sections readily show that the vascular injection and the bloody colour, are seated only in the most superficial parts of the *cutis*; whilst the deeper layers, and the immediate neighbourhood of the hair-follicles, are bloodless. The lanuginous hairs, rising through the *papulæ*, oc-

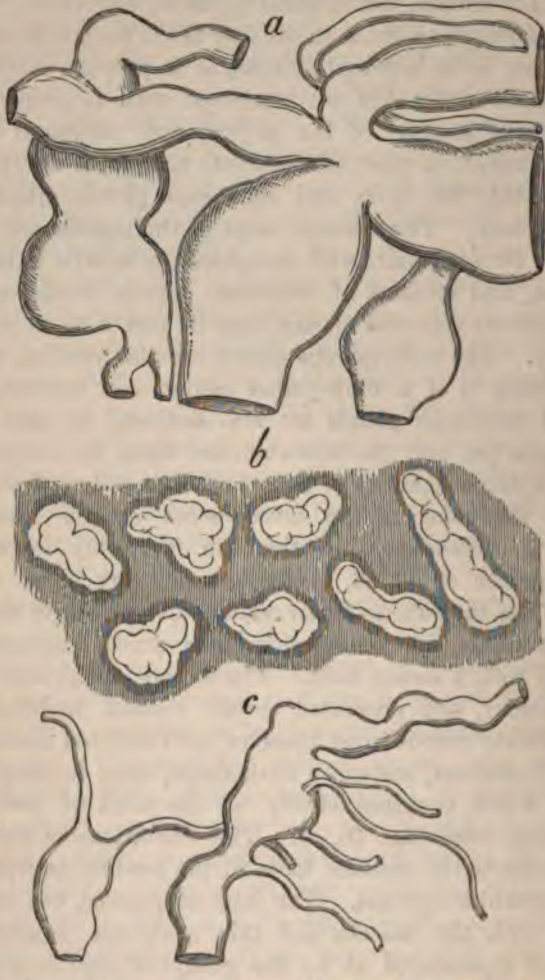
casionally assume a darker hue, but the subjacent sudoriparous glands do not differ from those in other situations where no *papulæ* exist.

In many cases, however, the exudation is not limited to the *papillæ* of the *corium*, but extends to the deeper layers. Sometimes it is formed rapidly, as in the case of the dropsical exudation in *scarlatina*, or in repeated attacks, as in *prurigo*, *eczema*, &c. The functions of the skin are interfered with in proportion to the degree of atrophy of the *corium*, and subjacent organs. The integument, in cases of inveterate *eczema*, is dry, shining, and wrinkled, the hairs and sebaceous glands disappearing almost entirely. The vascular loops of the *papillæ* are usually injected. Stunted hairs with atrophied bulbs little larger than the shafts, and remains of sebaceous glands metamorphosed into amorphous coloured masses, may be met with, though not frequently. The sudoriparous glands are also wanting, and the adipose tissue is of a dark-yellow colour, and rarefied. The hairs and sebaceous glands are also deficient in cases of inveterate *prurigo*, and the subcutaneous tissue is condensed, or contains a large quantity of free, brownish-yellow pigment.

When the veins of the *subcutaneous cellular tissue* are varicose, the circulation in the skin is readily interrupted, in consequence of which, exudations are very prone to take place. Thus the subcutaneous cellular tissue around the *anus*, in a case under our observation, was much condensed, and infiltrated with a serous fluid. The surface of the skin was of a violet colour, and presented several smooth nodular elevations. Minute venous twigs dissected out exhibited considerable saccular dilatations, some of a flask-shape, some forming lateral pouches, which occurred chiefly at the point of junction of two or more veins (fig. 46, *a*). The dilatations of the vessels extended also to the vascular loops in the *papillæ*, as was shown by perpendicular sections. The injected *papillæ*, cut off horizontally, with the smooth and thin *epidermis*, exhibited the appearance represented at *b*; the groups of *papillæ* were embedded in an abundant brownish-yellow pigment, indicated in the drawing by the darker shading. The vessels of the *papillæ* within the light-coloured spaces (in *b*) appeared, in the horizontal view, as excavated red spots. In order to make the observation more clear, the horizontal section was treated with carbonate

of soda. In several hemorrhoidal nodules, as they are termed, exudations were observed in the subcutaneous tissue, which was hypertrophied, and contained varicose veins.

FIG. 46.



Exudations may be poured out in such quantity in circumscribed portions of the skin, as by degrees entirely to destroy the cutaneous tissue. In place of which, we then have a surface covered with the exudation—a *cutaneous ulcer*—whose external aspect depends upon the physical properties, and the greater

or less capability of organization of the exudation. Thus, an ulcer, the bottom of which is covered with a tolerably consistent fibrinous exudation, presents a different aspect from that exhibited by one in which merely a thin serous fluid is effused. In the same way, a diversity of appearance necessarily results, according as pus-corpuscles, or the elements of connective tissue, &c., are formed from the exudation.

We have here selected for illustration, an instance, in which the integument of the *scrotum*, in a case of hydrocele, was almost entirely destroyed, and replaced by a substance resembling caoutchouc in consistence. It consisted (fig. 47, *a*) of parallel, dirty-yellow, streaked layers, between which, here and there, brownish-yellow pigment-molecules were visible; these were also grouped (*b*), sometimes into spherical, sometimes into elongated corpuscles. Aggregations of fatty molecules also occurred. It should here be repeated, that the streaks in *a* and *b* must not be confounded with connective-tissue-bundles, which may always be dissected out; whilst, in the present case, nothing but tabular corpuscles, and not a single fibre could be obtained, after various attempts. The scattered, granular, and coloured elements in *b*, should perhaps be regarded as newly formed organic elements, fallen at once into a state of involution. On the surface of this dense layer of exudation, glistening plates were visible even to the naked eye, which proved to consist of *cholesterin*.

Fig. 47.

In exudations of the integument, vegetable or animal parasites are also not unfrequently observed.

3. Mucous membranes.

When the delicacy of the epithelial layer of the mucous membranes in general, except in the mouth, *œsophagus*, *vagina*, and *palpebræ*, is considered, it is easy to comprehend that exudations poured out from the *corium* cannot produce any

mation. If the clear fluid be heated, a finely flocculent cloudiness is produced, caused by the precipitation of albuminous molecules. Sometimes a deposit may be noticed (fig. 45), in the form of a membrane, plicated like a structureless tunic (as for instance, the capsule of the lens) (*a*), which extends over a considerable surface, or is thrown into folds like a drawn curtain. This substance is unaffected by acetic acid. Whether it be of a colloid nature, must be ascertained by more precise investigation. When the contents of the vesicle have become opaque, numerous pus-corpuscles will be found in it. Not unfrequently, also, minute extravasations of blood take place from the surface of the *cutis*, and redden the contents of the vesicle.

The *epidermis*, which is separated from the parent surface by the layer of exudation poured out beneath it, necessarily dies and is thrown off, to be subsequently replaced by a new *epidermis*. In many skin-diseases, the *exudations in the papillæ* of the corium are so scanty at each spot, that the *epidermis* is merely raised in the form of a diminutive vesicle, as in *miliaria, eczema, herpes*, &c.; but occasionally several of such vesicles will coalesce. The exudation, which is poured out in small quantity, sometimes appears to thicken, owing to the greater proportionate amount of protein-substances which it contains, as the watery constituent evaporates, producing more consistent papular elevations, as in *measles, lichen*, and *prurigo*.

Our investigations of the *papulæ* of the last-named disease have shown that the larger ones are frequently filled with a yellowish fluid, and several hairs may be observed seated upon one *papula*. Occasionally, with a strong lens, numerous groups of red points, at uniform distances apart, may be observed towards one or other side of the larger as well as of the smaller *papulæ*, manifestly corresponding to the injected vascular loops of the *papillæ*. *Papulæ*, tinged with blood, are also occasionally met with, most probably produced artificially by scratching. The smaller sort are furnished only with a single central hair. Perpendicular sections readily show that the vascular injection and the bloody colour, are seated only in the most superficial parts of the *cutis*; whilst the deeper layers, and the immediate neighbourhood of the hair-follicles, are bloodless. The lanuginous hairs, rising through the *papulæ*, oc-

blood only at intervals, or are quite empty, the recurrent vessel alone being injected (*c*). The latter vessels usually unite in pairs, in such a manner that either the contiguous ramuscules or the first and third, or the first and fourth, recurrent twigs are conjoined. Effusions of blood also take place in the *villi*; in addition to which, ecchymosed spots are met with, or, in more rare cases, even considerable spaces in the mucous membrane of the small intestine appear suffused with blood. A portion of a mucous membrane in this condition, removed horizontally (*d*), exhibited larger and smaller, light, oval spots, corresponding to the Lieberkühnian glands.

But the injection may be inconsiderable and yet the exudation be abundant. This is the case, for instance, in very fluid, rapidly formed exudations in the choleraic intestinal mucous membrane, in which we may conceive that the blood-corpuscles give off their colouring matter with the exudation, as we have supposed to take place in the fibrinous exudations of serous membranes. In like manner, also, in croupose exudations, which, as is well known, also arise very rapidly—for instance, in croup and *pneumonia*,—the vascular injection in general is but trifling or even wholly inappreciable.

Exudations on the surface of mucous membranes are either a thin fluid or viscous, of gelatinous consistence or resembling a coagulated protein-substance (casëin, fibrin).

The *limpid serous* exudations of mucous membranes present no peculiar morphological elements; the epithelial cells contained in them, when in large proportion, cause slight turbidity, and are manifestly detached by the quantity of exudation collected on the surface of the *corium* of the membrane. But frequently very few exist, so that it might be supposed that they may be destroyed by the maceration to which they are subjected. It remains, however, to consider that detached *epithelium* can only justly be looked for at the commencement of the exudation, since the simple layers of which it is composed, are thrown off by the first effusion. The yellowish-red colour of the thin fluid exudations (as, for instance, at the commencement of *coryza*), depends upon red blood-corpuscles in a state of suspension, afforded by the ruptured minute vessels of the mucous membrane.

These thin exudations gradually thicken by the increase of

mation. If the clear fluid be heated, a finely flocculent cloudiness is produced, caused by the precipitation of albuminous molecules. Sometimes a deposit may be noticed (fig. 45), in the form of a membrane, plicated like a structureless tunic (as for instance, the capsule of the lens) (*a*), which extends over a considerable surface, or is thrown into folds like a drawn curtain. This substance is unaffected by acetic acid. Whether it be of a colloid nature, must be ascertained by more precise investigation. When the contents of the vesicle have become opaque, numerous pus-corpuscles will be found in it. Not unfrequently, also, minute extravasations of blood take place from the surface of the *cutis*, and redden the contents of the vesicle.

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usually to consist of granular, often brownish-yellow, frequently numerous, superimposed layers; flocculent shreds and, more rarely, filamentous reticulated masses may, with care, be isolated. The brownish-red particles which often exist, are amorphous, orange-yellow, flocculent coagula, deriving their colour from the *hematin* of the blood-corpuscles. In the exudation, the red colouring matter sometimes undergoes a change, so that it is no longer extracted by water, as it is in the red blood-corpuscles; even acetic acid exerts no influence upon these flocculi thus impregnated with altered hematin. Among newly-formed elements, besides those above described, roundish or elongated *nuclei*, pus- and granular corpuscles (fat-granule-globules) are those which most commonly occur.

We have here to notice some yet more delicate, round, or usually oval, flattened corpuscles, (fig. 49, *a*), composed of equal-sized minute molecules, about 0·04‴ in the long diameter, and which are met with in the exudations poured out on the surface of the mucous membrane, in diarrhœa, dysentery, and cholera. Occasionally they appear also grouped in larger numbers (twenty or more). Their form is often more elongated. Acetic acid renders them of a dirty yellow colour. These bodies are probably Lebert's "pyoid-globules" transformed, differing, however, in their flatness, and the absence of an investing membrane.

Between exudations of this consistence, and others on the mucous membranes to be subsequently described, numerous intermediate forms exist, which may be conveniently studied, especially in the intestinal mucous membrane; frequently in one and the same case. Thus croupose exudations occur in what is termed the typhoid stage of cholera, in the intestinal tract, together with the gelatiniform. In *typhus*, also, thin fluid exudations are very frequent, together with those of the croupose kind. In croupose pneumonia certain portions of the lungs appear to be infiltrated with a serous exudation.

It is at once obvious that the exudations are not collected only on the surface of the mucous membrane, but that they infiltrate all its tissues, such as the follicles and submucous *stratum*. A considerable *swelling* of the membrane is thus produced, which is necessarily less apparent in the human subject, when dissected after death. If the texture of the mucous

membrane is infiltrated with a serous exudation, it collapses when cut, by the escape of the fluid. The gelatiniform infiltration is not unfrequently interspersed with sanguineous suffusions in the submucous tissue.

The *villi* of the intestinal mucous membrane, in exudative processes, undergo several morphological changes; they lose their *epithelium* and their natural transparency. A fine, molecular, brownish-yellow material is seen in the interior, and especially at the *apex* (fig. 49, *c*), which is occasionally accumulated in such large quantity that the greater part of the *villus* is rendered nearly opaque. But at the same time, a gradual diminution of the molecular accumulation from the apex of the *villus* towards its base, may always be noticed. Together with the fine molecules, there are usually apparent, larger, sharply bordered granules, frequently agglomerated into granular bodies of various dimensions, (fig. 49, *d*). In this case there can perhaps be no doubt that an infiltration of the *villus* has taken place, whilst *c* might represent only a form of involution. *Villi*, in this atrophied condition, are observed, especially in old persons.

Fig. 49.

When the exudative process in the intestine is excessive, the *villi* contract remarkably, and their transverse diameter is lessened in consequence of the folds into which they are thrown. We have frequent opportunities of seeing this, very extensively in typhus.

In consequence of repeated alternations of *hyperæmia* and *stasis*, extensive collections of transuded colouring matter appear to take place at the points of the *villi*; in consequence of which, a precipitation of it occurs, assuming the form of red or blackish-brown, larger or smaller granules (fig. 49, *b*). These black-spotted *villi* usually exhibit the recurrent vessel filled with blood (at +). Collections of free, reddish-brown and black pigment are very frequently met with in all parts both of the *corium* of the mucous membrane as well as in the sub-

mucous tissue. With this is associated a more or less considerable opacity and thickening of the membrane. Depositions of pigment, also, may often be noticed, following the course of the atrophied vessels, upon more extended examination of mucous membranes in this condition, which have been the seat of an exudative process. Black specks of pigment are disposed in longitudinal series, and a lateral series may occasionally be noticed. The walls of the vessels, under these circumstances, disappear.

The morphological changes, undergone by the *glands* belonging to the mucous membrane, in exudative processes, depend upon the kind and amount of the latter. It is clear that the simple follicular and the compound ramified glands of the membrane will be impeded in the formation and excretion of their secretion, and the gland-cells be placed under unfavorable circumstances, as regards their vital conditions, for the exercise of their decomposing powers upon the materials afforded by the blood. The gland-cells are subjected to a retrograde metamorphosis, the rapidity of which is in proportion to the amount of exudation. Thus in a case, recorded by Professor F. Müller, of a horse which died within twenty-four hours, of a violent diarrhœa, some of the Lieberkühnian glands of the opaque mucous membrane of the small intestine remained attached to it in the form of dirty, dark-grey, semi-transparent, accurately defined corpuscles; whilst others had become detached, the points at which they had been affixed being indicated by lighter coloured spots.

The prominences upon the *inner surface of the stomach*, which have occasionally been described as *polypi of the mucous membrane*, are to be regarded as mere infiltrations, and by no means as of new formation. They are soft, reddish projections, usually about the size of a bean. Exudations deposited around groups of peptic glands, cause the latter to project above the level of the surface of the mucous membrane. Although these glands, even in the moist state, are readily recognizable as such, still, for a general survey of them, it is requisite to examine entire sections of portions of the mucous membrane, which have been boiled in acetic acid and dried; in which the elongated follicles, in their occasionally serpentine course, with bifurcating divisions, may be distinctly traced. In this case also the glandular

substance may wholly or partially disappear in consequence of the exudation, nothing remaining but a sort of honey-comb structure, which should be viewed under a less magnifying power and by reflected light.

The enlargement of the solitary and of Peyer's glands is very often connected with a vascular injection, which we have represented in fig. 50, taken from a solitary gland in the lower part

Fig. 50.

of the *ileum* in a case of typhus. At *a* we see the enlarged, closed capsule; in the interior arching vascular loops are visible, but which in the present case were only partly filled with blood; these vessels emptied themselves into veins which encircled the capsule and opened into larger venous trunks (*c c*) in the submucous cellular tissue. The recurrent vessels, also, of the groups of villi (*b b*) appeared to be injected.

The injection of the Peyerian patches resembled, in all essential respects, that of the solitary glands; except that the venous, coronary vessels surrounding each group of capsules were larger, and the latter more usually tinged of a blood-colour by sanguineous extravasations. The vascular injection, where the Peyerian patches are more infiltrated, often penetrates more deeply, so that, even from the outside of the intestine, the characteristic injection of the muscular coat may be recognized.

The swollen capsules, both solitary and aggregated, present a greyish, glistening aspect, and contain the well-known

nucleated substance with scattered molecules. The *nuclei* are insoluble in acetic acid. Alkalies render their outlines less distinct, or even cause their entire disappearance. The molecules, also, frequently constitute the sole contents, especially in the swollen Peyerian and solitary glands in *typhus*. The contents are coagulated by dilute acetic acid, as is manifested by a considerable degree of opacity when they are viewed by transmitted light. If the acid be allowed to act, for some time, upon a portion of intestine in this condition, a greater resistance will be observed in the solitary glands, which, when the epithelium is scraped off, will be distinctly apparent, and they will be frequently noticed where not previously visible. There can be no doubt, therefore, that a coagulable fluid collects within the capsules, both in *typhus* and in the typhoid stage of cholera.

When the deposition of pigment is abundant, the solitary and Peyerian glands appear surrounded by a black border.

The glands in question not unfrequently burst, a circumstance which has given rise to erroneous notions as to their structure. The capsules may also collapse, in consequence, simply, of the absorption of their contents. Owing to one or other of these occurrences, the Peyerian patches acquire the well-known reticulated aspect, since the mucous membrane surrounding the individual capsules assumes the form of a projecting border; and entire patches present the appearance of a fine sieve.

The thinness of the *corium* of the mucous membranes, is the cause of the readiness with which losses of substance in that tissue take place in exudative processes. In this way arise *ulcerations of the mucous membrane*, the bottoms of which are covered by various kinds of exudation. The latter not unfrequently rises above the level of the surface of the membrane, in the form of a plug (well known in typhus), which, in the intestines, becomes tinged of a deep dirty-yellow colour, by the colouring matter of the bile. The morphological constituents of this plug are seen to consist simply of an opaque, fine molecular substance, with solitary and aggregated fat-globules, when its more superficial layers are examined; in the deeper portion, it presents empty vessels, elastic and connective tissue, infiltrated with the molecular material. The portion of the mucous membrane put out of the pale of nutrition, together with the

subjacent cellular substance, is thrown off in the form of a slough. When, under these circumstances, the exudation undergoes decomposition, whose product has a peculiar nauseous smell, the process is termed *sphacelation*. To this are usually superadded, minute extravasations of blood, communicating a diffuse redness to the parts implicated, and by its further change, inducing a brownish or dark-greenish colour.

It should here also be noticed, that the exudation may be confined wholly to the submucous tissue, and even to circumscribed portions of it. We also regard the *melanotic colouring of the follicles*, as an analogous process to the above. It should, in the first place, be remarked, that the solitary glands, which, in their structure, precisely correspond with the Peyerian patches (so that, in fact, the latter might be termed agglomerated *glandulæ solitariæ*), are also termed follicles, although the expression follicle (*sacculus*) would be better applied to the Lieberkühnian glands, which are cæcal, elongated *sacculi*, opening on the surface of the mucous membrane. We have not as yet been able to satisfy ourselves that the suppuration in these cases actually takes place in a solitary follicle, and, consequently, believe that this follicular theory will have to be relinquished, as it has been in the case of most of the inflammatory processes in the skin.

The exudations, throughout the whole tract of the intestine, are very frequently the seat of vegetable parasites, which may be easily recognized by their proper characters. Care must be taken not to deem any *accidental products in the contents of the intestine as an exudation*. Thus in the cheesy, pultaceous, dirty-white fæcal matters evacuated by a woman, who, according to Prof. Chiari, had eaten nothing but bread and milk, elliptical bodies, of various sizes, and of strongly refractive power, formed the principal constituent. Concentric lamination could be perceived in several of them, so that it was at once supposed that they were amylaceous grains. This was confirmed upon the addition of tincture of Iodine when all the granules assumed the characteristic, dark-blue colour. Consequently there could be no doubt, that these corpuscles, which gave the light colour to the fæces, were undigested starch-grains.

A pale-coloured filamentary structure, about a foot in length

and 0·15″ thick at one end, and 0·78″ at the other, which was discharged by a lunatic, by stool, when examined, proved to be composed of connective tissue, whose *nuclei* were rendered manifest by the action of the acids in the stomach, as they are by acetic acid; and here and there, regular, parallel, fibrous bundles remained quite distinct. The patient presented no symptoms of inflammation of the bowels.

Similar undigested remains of aliment were afforded by a hypochondriac. These were soft white strings, with filamentary ends, and isolated, smaller *flocculi*, together with tubular bodies of firmer consistence, one of which was bifurcated. The light-coloured strings consisted of a hyaline matrix, containing elements like fat-globules, which in some parts, though not so distinctly as in the previous case, resembled connective tissue treated with acetic acid. The tubular bodies proved to be blood-vessels, (arteries up to a diameter of 0·04‴), by the remaining structure of the annular fibrous and fenestrated tunics. The sheath of connective tissue had been absorbed in the process of digestion. The tubular structures, in this instance, as in many other, similar cases, had for a long time been regarded as *entozoa*; but nothing but the grossest ignorance on the subject could have led to such a mistake. Serous exudations in the tissues of the mucous membrane of the bladder are connected, as we have satisfied ourselves, in some cases, with varicose dilatations of the vessels (fig. 46, *c*). These are most remarkable at the *caput trigonum*, and are visible, even to the naked eye, as red eminences, presenting irregular sinuous pouches, into which vessels of capillary dimensions open.

§ 4. Vessels.

In speaking of inflammation of the blood-vessels, we can only refer to those which are furnished with nutrient vessels in their walls, the latter of course being necessary for the setting up of the exudative process. The capillaries and minute arterial or venous twigs, which possess no *vasa vasorum*, are incapable of inflammation, whilst it can be shown, as will be stated subsequently, (*vid.* granular corpuscles), that *plasma* penetrates through the delicate walls, and gives rise to the formation of new elements on the outside.

A cardinal question in the establishment of a theory of inflammation of the vessels has reference to the distribution of the *vasa vasorum*, viz., as to whether they are confined simply to the cellular coat, as most anatomists suppose, or whether they also extend into the annular fibrous layer, or even into the longitudinal, as is also asserted by competent authorities. In a pathologico-anatomical point of view, we regard the latter statement as the more correct, since it is only by such an assumption that several pathological facts can be explained.

It may be regarded as an ascertained fact, that the innermost layers of the coats of the vessels are non-vascular, whence Virchow deduces the categorical conclusion, that a capillary *hyperæmia* of the internal tunic, an inflammatory reddening of it, is impossible. A simple redness from imbibition, such as is often apparent on the inner surface of the larger vessels, is readily determined to be of that nature, by means of the lens, inasmuch as it nowhere presents any injected vessels, which always exist in inflammatory reddening. The redness on the inner surface of the larger arteries, depending upon imbibition with the colouring matter of the blood, is uniform, and exists accompanied with phenomena indicative of putrefactive decomposition.

Virchow has proposed a question, as to how the nutrition of the inner layers of the arterial tunics is effected; whether a molecular change or a continual new-formation can be shown to take place in them, and whence, in this case, the plastic and nutritive *plasma* for the epithelium, and the longitudinal fibrous layer, is derived. He propounds two possibilities: either the *plasma* penetrates from the *vasa vasorum* into these layers, so as to reach their surface, in order, ultimately, to afford the material for the formation of the epithelial cells; or it passes from the blood circulating in the arteries into the coats of the vessels, so that certain parts of them require no capillaries in addition. The fact, however, that the membranes of the capillary vessels and of the arteries which have no capillaries, can hardly be nourished in any other way, has determined Virchow to adopt the latter of the above possibilities, although it is unnecessary to regard the formation of cells as taking place directly from the passing fluid, since it may be supposed that the subjacent membranous layers appropriate a portion of the *plasma*, and allow

the rest to become fixed on their surface or to return. We are convinced that this view of Virchow's, with respect to the nutrition of the internal membrane of the vessels is correct.

The nutrition of the strong, annular, fibrous layer in the larger arteries proceeds immediately from the capillaries, if we admit the statements of those anatomists who assert the existence of capillaries in those layers; in the contrary case, the nutritive plasma must be afforded in part from the vessels of the cellular coat, in part from the blood circulating in the arteries.

The exudative process is limited, as is self-evident, to separate portions of the coats of the vessel. The pathological changes which the different layers undergo, are, essentially, the following: the cellular coat presents the same conditions as the cellular tissue, elsewhere, when inflamed; it is reddened, swollen, and the vessels with numerous undulating branches are filled with blood. The *hyperæmia* gradually diminishes, and, in man, has not been observed in the annular, fibrous coat, the hyperæmic stage having already advanced to the formation of an usually solid, inflammatory product. In his experiments upon the carotid artery in Dogs—which vessel he irritated with different mechanical and chemical means, and examined at various intervals (one to five days),—Virchow found that the acute inflammatory phenomena corresponded, in all respects, with those usual in inflammation of the parenchymatous tissues. Redness (*hyperæmia*) and swelling (thickening, exudation) were very distinctly manifested, particularly in the outer layers. The exudation did not extend beyond the outer surface of the longitudinal fibrous coat. It assumed the form of a homogeneous or molecular substance, deposited among the structural elements, and was usually soon metamorphosed into a sanious fluid (putrefaction), or occasionally into pus. At the commencement of the process, at the stage of thickening of the coats by a solid exudation, the calibre of the artery is diminished, whence there esults a corrugation of the inner coat, which loses its even nd polished aspect. Virchow compares this condition with e plication of the mucous membrane of the stomach and rge intestine, when the substratum is diminished (*état mmelonné*), and with the hypertrophied mucous membrane the *uterus* at the beginning of pregnancy. He never

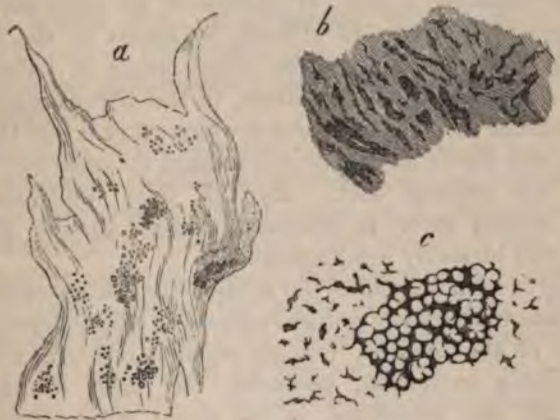
observed an exudation on the free surface of the inner coat of the arteries in any experiment, whether the irritation were applied from without or from within, and effected by chemical or mechanical substances. The apparent exudations in that situation were either coagula of the blood, supplied by the collateral vessels of the *carotid*, or sometimes detached portions of the inner coat.

This necrosis of the inner arterial tunic, induced by the accumulation of an exudation in the annular fibrous layer, causes the detachment of isolated portions of it; and in this way are produced, on the inner surface of the artery, spaces resembling shallow ulcers, in which the innermost smooth layer is wanting, and whose bottom is covered with a soft, yellow, pultaceous deposit of cholesterin and olein; the edges sometimes appearing to be undermined. In connexion with these necrosed portions of the inner coat of the vessel, minute, annular sugillations are frequently seen, which are formed, in the softened places, by the blood circulating in the artery.

These pultaceous, soft masses represent the *atheromatous deposits*, as they are termed; they are situated externally to the longitudinal fibrous layer, and belong to a later stage of the exudative process, to that, in fact, in which a partial *necrosis* of the coats of the vessel has been caused by the exudation. When examined microscopically, the pultaceous substance presents, besides the above-mentioned fatty matters, also flaky corpuscles, earthy particles effervescing with acids, and the remains of the necrosed tissue. Towards the cavity of the vessel, the deposit is covered with a delicate membrane, so that the inner surface appears smooth, although it assumes a whitish colour from the chiefly fatty contents of the subjacent *atheroma*. Lamellæ of the delicate membrane are seen to be constituted of hyaline, highly flexible plates, the edges of which appear shreddy and torn (fig. 51, *a*), with groups of imbedded fat-globules, which in many places are so numerous as almost entirely to cover the membrane. The colour of the fatty molecules occasionally passes into a brownish-yellow. In oblique sections of the delicate membranes, the step-like arrangement of the layers may be displayed, which, however, are not to be regarded as any kind of exudation, since, by a higher magnifying power, the delicate striation, proper to the longitudinal fibrous coat,

can be perceived; and, besides this, the polygonal epithelial cells, resting upon the surface, remain visible in many places.

FIG. 51.



These pultaceous deposits are, not unfrequently, replaced by others of a tougher and *cartilaginous* nature, and of a structureless, transparent substance, which are not changed by acetic acid, and, by the reception of earthy salts, become converted into *ossific plates*. The latter, also, are at first lined on the inner surface by the longitudinal fibrous layer, which is gradually necrosed, and detached from the edges of the plates, which, when thus exposed, project into the canal of the vessel. When polished, and closely examined, these plates never present the characteristic corpuscles of bone, nor any system of medullary *canaliculi;* for the irregular spaces filled with calcareous salts (fig. 51, *b*), cannot, in any way, be regarded as incomplete bone-corpuscles and *canaliculi*. It follows, therefore, that this kind of deposition should not be termed ossification of the artery, but *cretification*. When the examination is continued, from these plates towards the lighter-coloured spots, scattered groups of globular bodies will be perceived (fig. 51, *c*), which are rendered very distinct by the interstices between them. These globular masses resemble, in all respects, those first accurately described by J. Czermák in the dentine, and termed by him "globular masses," and "interglobular spaces." We think

that they should be described as protein-masses (colloid ?) impregnated with calcareous salts.

The pathological metamorphosis of the *annular fibrous layer* consists, chiefly, in the deposition of fatty molecules between the more consistent layers. If portions of the latter are raised, proceeding from within to without, by means of the forceps, the fatty molecules will be seen lying, partly in longitudinal rows, partly in sacciform dilatations, in the fibrous network of the membrane in question, towards whose outer layers the fatty contents and the yellow colour due to them increase, but ceasing towards the cellular coat. By this fatty infiltration, the annular fibrous layer is rendered thicker, though its consistence and elasticity are diminished.

We agree with Engel, in the opinion that this accumulation of fatty molecules should not be regarded as a fatty degeneration like that of the muscles, looking upon it rather as a usually unorganizable exudation, assuming the form of minutely divided fat, and connected, in its origin, with a hyperæmic condition of the cellular, and, perhaps, of the annular fibrous tunics.[1] In rare cases, *new formations* are produced *on the innermost layers of the annular fibrous tunic.* In a softened mass, situated beneath the inner coat of the *aorta,* which was elevated by it, Virchow observed immature cell-formations, free, smooth nuclei, and minute cells, some uni- some multi-nuclear, with homogeneous contents. In this case, besides the semi-cartilaginous, thickening layers, as they are termed, the aorta presented cretified and fatty *plaques;* whence it is apparent, that, even together with the so-termed atheromatous deposit, a process of cell-formation may co-exist. The same observer has also shown, experimentally, the possibility of suppuration beneath the inner coat.

It is thus obvious, that an exudation, or increased transudation, may take place in the annular fibrous layer; and that, in

[1] [Some excellent observations on the subject of fatty degeneration of the arteries, in which nearly all the facts noticed in the text and others of equal importance are given, will be found in a paper by Mr. Gulliver, in the 'Med.-Chir. Transactions,' 2d ser., vol. viii, p. 86, 1843. The true nature of atheromatous deposits is there pointed out, so far as I am aware, for the first time, at any rate in a satisfactory and detailed manner. Although the fact of the presence of fatty matters had been previously indicated in them, by Bizot, Cruveilhier, and Gluge.—Ed.]

many cases, this product is even organizable. Now, whence this exudation is derived, whether from the blood-vessels of the annular fibrous coat itself, or from those of the cellular coat, depends, as has been already stated, upon the existence, which, it is true, has yet to be established, of blood-vessels in the annular fibrous coat. If we assume the existence of these vessels, it becomes the more easy to explain the occurrence of a new-formation of elementary organs beneath the inner coat of the artery.

In speaking of the atrophies of the vessels, we have already shown that their elasticity and contractility are affected by the fat which accumulates in the walls, as a consequence of the insufficient supply of nutriment; and, therefore, that from the greater afflux of blood, and the hindrance to its return, an expansion takes place at the points more copiously infiltrated with fat, from which, owing to its diminished contractility the vessel is unable to regain its pristine calibre. The same mode of dilatation may also be conceived to occur in inflamed vessels, except that in this case it would reach a greater extent, in proportion to the weakness of the wall of the vessel, induced by the exudation deposited in it.

Now the stream of blood must be delayed in the dilated portions of the vessel, or may even be partially arrested in some of the hollows, or perhaps entirely stopped, when a coagulum is formed, by which the canal of the vessel is obliterated, and which undergoes several morphological changes. On one occasion, we examined an *old coagulum*, contained in a very large aneurismal sac of the aorta. It was compact, leathery, and tough, and consisted of several fibrinous layers, marked with yellow and rusty-brown streaks, so that the cut surface was not unlike agate. The outer surface, applied to the wall of the artery, had a rough, velvety aspect, was for the most part of a reddish-brown colour, and in some places of a dirty yellow. The coagulum was softer towards the centre, which was occupied by a more lax, yellowish, fibrinous substance. From the denser portions, sections could be made, presenting between the dirty, reddish-brown streaks, scattered granular corpuscles, of various dimensions, for the most part of a rounded figure, but occasionally furnished with processes. The reddish-brown fibrinous coagulum was rendered pale by

acetic acid, though still retaining a light yellow colour. The granular masses were not affected by that acid. The softer portion towards the centre contained numerous white blood-corpuscles, and a large quantity of a molecular substance.

In the aneurismal mesenteric artery of a Horse, the coagulum, which contained several *strongyli* (a circumstance of freqnent occurrence in old horses), was soft and spongy, and in many places distinctly puriform. In the latter portions were numerous granular corpuscles, some rounded, some elongated, many of which, of a lighter colour, presented a vesicular *nucleus*. Together with these, were numerous, solitary and agglomerated fat-globules; and white blood-corpuscles existed everywhere, in such large numbers as almost to exceed the red in amount. To the inner wall of the aneurismal sac adhered a yellowish, spongy, lacerable substance, containing, chiefly, *nuclei*, which, in form and size resembled those of the lymphatic glands, *thymus*, &c. Those parts of the inner surface of the sac, which were covered with this substance, had lost their smoothness. In the gelatiniform deposit, $\frac{1}{2}$—1‴ thick, on the inner surface of the descending *aorta*, of a Man who had died of periostitis of the bodies of the dorsal *vertebræ*, we, in like manner, found a large quantity of variously shaped *nuclei* and numerous fat-globules. Besides these elements, the exudation contained flattened cells, with rounded *nuclei*, in a state of fatty degeneration, and which perfectly corresponded with the epithelial cells usually occurring in that situation. In the somewhat deeper layers of the exudation, lastly, elastic, fibrous networks were visible, manifestly referrible to the longitudinal fibrous layer. The *tunica media* contained a large quantity of fat-globules, and the cellular coat was much injected.

The question, whether this nucleated substance on the inner surface of the artery, should be regarded as a deposition from the circulating blood, or, as formed from the exudation which was originally poured out beneath the longitudinal fibrous layer, we think must be decided in favour of the latter supposition, since these nucleated formations are intimately connected with the wall of the vessel, and cannot be removed like particles merely adherent to the smooth *tunica intima*.

Luschka's observations on the subject of *endocarditis*, should also, here, be noticed. Having proved that the *endocardium* is

constituted essentially of the same elements as the coats of the vessels, he proceeds to demonstrate more precisely the pathologico-anatomical changes in that disease. In the first step of the *hyperæmia*, the vessels of the cellular and elastic layers of the *endocardium* appear to be filled with blood, although the latter still retains its normal brilliancy and smoothness. In the stage of effusion, the blood-vessels are more or less concealed by the exudation, whence is produced a dirty-red, sometimes uniform, sometimes spotted colour. So long as the exudation is confined to the cellular and elastic layers, he found that the *endocardium* retained its smoothness and glistening aspect; but when the non-vascular layers and *epithelium* were infiltrated, as is always the case in acute *endocarditis*, the smoothness and brilliancy were lost, and various degrees of opacity and changes of colour became apparent. He very truly remarks, that the exuded matter adhering to the free surface of the *endocardium* was not parted from the deeper *strata* of the exudation by any structural layer, but was directly continuous with them. When the exudation deposited beneath the longitudinal fibrous layer and the *epithelium* was organized, its growth advanced into the cavity of the heart, the *endocardium* being destroyed. Consequently, the same changes are here observable, as have been shown to take place in the arteries.

When we speak of *inflammation of the veins* (*phlebitis*), the expression can be understood as applying only to that of their walls; consequently, when the signs of inflammation are wanting in the latter, all criterion fails by which the product accumulated in the vein can be characterised as an inflammatory product. Thus, we not unfrequently meet with pus in a vein whose walls exhibit no indication whatever of inflammation.

The phenomena attending *phlebitis* are analogous to those which accompany inflammation of the arteries. The *hyperæmia* is confined chiefly to the cellular coat, which is not unfrequently, also, the seat of sanguineous suffusions of greater or less extent. According to Rokitansky, the injection, in the veins, involves the annular fibrous coat. That coat appears vascular, but more frequently the injection of its tissue and the consequent redness have already disappeared, besides which the

surface presents minute red points from extravasations in the proper substance of the tissue. The injection could in like manner be traced into the innermost layer, but this never exhibited any red injection. When exudation has taken place, both the outer and middle layers are thickened and infiltrated with a fluid which is sometimes thinner, sometimes thicker, sometimes transparent and at others turbid. The innermost layer either retains its smoothness, although rendered grey and opaque by the subjacent exudation and speckled with blood-red or brown-red spots of extravasation, or the surface is roughened by the spongy-filamentous exudation adherent to it. In the latter case the *tunica intima* is wanting, and the exudation, usually metamorphosed into a nucleated substance, rests immediately upon the middle coat of the vessel. Rokitansky has occasionally found the layers of which the inner membrane is constituted, (together with the valves), detached from the annular fibrous layer, or even thrown off in the form of a tube.

In consequence of this infiltration, the coats of the vein are softened in their texture, and their elasticity and contractility so far diminished that they cannot afford the same resistance to the circulating blood, whence a dilatation of the relaxed venous walls the more readily ensues. This can take place only at the expense of the thickness of the latter; but since the veins, independently of that, have very thin walls, they are easily ruptured, when extravasations of blood take place in the parenchyma of the organ.

If the calibre of the vessel remain dilated, a retardation of the current of blood will occur in those situations, or even a complete stagnation will be established in isolated parts, the blood coagulating into a plug by which the venous canal is obstructed. This plug afterwards undergoes various metamorphoses; among which, the excessive formation of white blood corpuscles is especially to be noticed, which, as is well-known, do not differ morphologically from pus-corpuscles.

The question now remains to be determined, whether the pus contained in a vein is produced by metamorphosis from the stagnant blood, or from an exudation which has been poured out *upon the inner surface of the vessel.* We know that the inner coat of the vessel is certainly non-vascular, consequently an exudation from the outer and middle coats only,

can be regarded as possible. But with respect to this, a capacity for transudation must be assumed to exist in the inner layer, in accordance with which we must suppose that the exudation is deposited on the inner surface of the vein in the fluid state; in which case, however, it would be removed by the current of blood. We fully agree with Luschka in assuming that the same thing obtains in the vessels as his observations have proved to take place in inflammation of the *endocardium.* He is satisfied, that is to say, that neither is it demonstrable by observation nor reconcilable with theory, that an exudation can in any way remain, or undergo metamorphoses, on the free surface of the *endocardium.* Consequently it must be admitted that the metamorphosing exudation is collected *beneath the inner layer of the vessels,* which undergoes a *necrosis* similar to that which we have described, as attacking the corresponding tunic in *arteritis.* We are, therefore, necessarily opposed to the view which would assume that the exudation may take place on the internal free surface of the vein, and consequently within its canal, and that the metamorphosis of the plastic forms of exudation is there effected.

The fact that the pus, in these cases, may be formed from the stagnant blood, and more especially from its *serum,* perhaps no longer admits of doubt, since the metamorphosis of the coagulated blood into a puriform fluid may be traced from the centre of the plug towards its periphery.

§ 5. Bone.

When the exudation is afforded by the vessels of the *periosteum,* that membrane will be found in a hyperæmiated condition. Its thickness is increased and its consistence diminished, the tense connective-tissue-fibrils being separated from each other by the exudation. The gelatinous effusion is often denser, assuming a lardaceous consistence, so that the proper tissue of the periosteum is entirely lost in it. The exudative process is sometimes limited to a small, circumscribed portion of the membrane, and is sometimes more extensively diffused. The surrounding connective tissue is usually found in an infiltrated condition, standing as it does in such close connexion with the *periosteum.*

From the free communication between the vessels of the *periosteum* and those proceeding from the surface of the bone, it is easy to understand that the exudation, in *periostitis*, may readily involve the superficial layers of the bone, of which occurrence their dull aspect will afford an indication. The consistence of the affected bone is, by this, somewhat diminished, and changes of colour occur, which, as Lobstein has remarked, are perceptible in the dry bone. Under these circumstances parts of the bone may be observed which have lost their natural colour and appearance, and in which may be noticed dark spots alternating with white. This change of colour, which is especially remarkable in the long bones, depends, on the one side, upon the *hyperæmia* of the medullary canals, and on the other, upon the deposition of the exudation, by which a rarefaction of the osseous lamellæ is brought about. At the same time, the nutrition of the affected portion of bone ceases, in consequence of which a superficial scale becomes necrosed, and is thrown off.

The exudation deposited in the *periosteum* is very prone to become *organized*, when it assumes a delicate villous aspect; its consistence is increased, and ultimately a new osseous substance is formed, which is in organic connexion with the subjacent bone. The elementary organs developed under these circumstances, upon examination, will be found to consist only of such as bear the closest resemblance to young connective-tissue-elements; they consist mainly of fusiform cells with an oval *nucleus*. We shall return to this subject more particularly when we come to the "formation of bone."

The exudation in the *periosteum*, when less organizable, may be transformed into a lardaceous membrane of considerable thickness, or become developed into a strong layer of connective tissue intimately united with that in immediate contiguity with the membrane.[1]

[1] [Scorbutic nodes, as they are termed, consist of a fibrinous deposit or exudation between the periosteum and bone, sometimes conjoined with a similar effusion in the superjacent connective tissue. This scorbutic effusion, though deeply coloured with blood, cannot, any more than the effusions among the muscles and into the tissue of the gums, &c., be regarded merely as coagulated blood, inasmuch as it is solid or semi-solid from the first, and rapidly assumes an imperfect kind of organization, that is to say, it will be found when recent and soft to contain an abundance

Pus is not unfrequently formed from the thin fluid exudation in the *periosteum*, and collects between that membrane and the bone, causing its partial separation. The bone is thus exposed, and its superficial layers being deprived of their nutriment, become spongy, and the process termed *exfoliation* takes place.

A special kind of exudation is seen in what are termed *gummata*. Lobstein describes it under the name of "*gummose periostitis*," and compares the contents of these nodular swellings, as respects their consistence, with a semi-fluid mucilage of gum arabic, and of the colour of currant-jelly.

The seat of these *gummata* he places in the tissue of the *periosteum* itself, or, more often, between that membrane and the bone. With respect to the more intimate constituents of this exudation, so far as we are aware, nothing has been ascertained.[1]

The exudation, as is well known, may also originate from the *interior of the bone*, the latter in this case undergoing various morphological changes, dependent upon the nature of the exudation, and its mode of distribution. The exudation is seated chiefly in the spongy part of the bone, of which satisfactory evidence is afforded especially in the long bones; the compact substance is not involved until afterwards. The exudations may undergo various modifications in one and the same bone, since they may be limited to separate portions.

Out of several, we will here adduce an instructive instance of inflammation of the *tibia*. In the superior and inferior extremities of this bone, an isolated collection of sanious fluid was found in the middle of the spongy substance. The *sanies* contained principally pus-corpuscles in a state of fatty degenera-

of fusiform nuclear bodies, and when older and more solid, to be richly furnished with new-formed capillaries, or vascular channels. On this subject, *vid.* Mr. Dalrymple's Observations on the Organization of Lymph in Cachexia, 'Med.-Chir. Trans.' 2d ser., vol. v, p. 212, and vol. ix, p. 70.—Ed.]

[1] [In syphilitic *gummata*, such for instance as are frequently observed on the frontal and breast bones, the contents are a glairy fluid, containing but few morphological elements. The latter consist chiefly of irregular molecules and colourless granule-cells, and granular masses, often consisting apparently of oily spherules surrounding a transparent mass, but notwithstanding the apparently complete separation of the *periosteum* from the bone, by this heterogeneous product, it rarely happens, if the case be properly treated, and the opening of the tumour be avoided, that any exfoliation takes place.—Ed.]

tion, and larger rounded *nuclei* belonging to flattened granular elements about twice or thrice the size of the pus-corpuscles. The collection in the upper part of the bone penetrated the *tibia* obliquely inwards and downwards, opening on its inner aspect with an oblique orifice (*cloaca*); superiorly, where the cavity was widest, it enclosed a bony *sequestrum*. The gelatinous deposit upon the medullary substance in the middle portion of the bone was interesting. It consisted of numerous, immature *connective-tissue-elements* with comparatively large, oval and elongated *nuclei*, containing 1—2—3 *nucleoli*, which had frequently escaped. These elements were for the most part lodged in a hyaline *matrix*. Numerous connective-tissue-fibrils could be detected in the denser portions of this substance, which were manifestly of new formation, since, in the normal condition, connective tissue is never found so abundant in the *medulla*. The absence of fat-cells also, in this situation, was very remarkable.

Besides this metamorphosis of the exudation into pus and connective tissue, its transformation into bone is to be noticed, whence in one case the circumference of the bone is increased (excentric new-formation of osseous *lamellæ*), or in another, its peripheral limits remain the same, and its density merely is augmented (concentric new-formation of osseous *lamellæ*). In the latter case, the new lamellar systems are deposited at the expense of the medullary canals and *cancelli* of the bone (*sclerosis*), whilst in the former an absorption of the osseous substance appears to proceed simultaneously with a partial new-formation, whence an enlargement of the medullary canals and cells is produced (*osteoporosis*). This rarefaction of the osseous tissue, is most striking in the more compact parts, as, for instance, in the cortical *lamellæ* of the long bones. The medullary substance existing in the more porous parts, is manifestly reddened, and the thin, arched processes of bone enclosing it, show the lamellar structure as distinctly as it is, otherwise, seen only in young bones in a state of development.

To prove that in *osteoporosis*, together with a marked rarefaction of the tissue, a new-formation of osseous substance from the exudation deposited in the medullary canals and *cancelli*, may also take place, the case of an *osteoporosis* of the *cranium* in an old mad woman, may serve as an instance. The increase

of volume was very considerable, especially in the frontal and occipital bones, whose thickness amounted to as much as 1·56″. The outer surface presented bluish-black spots, corresponding to the dilated, injected canals of Breschet; and on the inner surface projected verrucose and acicular osteophytes. The substance of the bone was spongy, so that it crumbled in the polishing of thin sections removed with the saw. Minute fragments, not so far disintegrated, when polished, exhibited a streaked, intercorpuscular substance, the appearance being caused by the decussation of the osseous lamellæ at various angles; their connexion was more lax than it usually is in the normal condition. The diversity of form of the excessively numerous bone-corpuscles, was also very remarkable. These had sometimes the form of elongated fissures, were sometimes rounded, sometimes irregularly distorted; their jagged prolongations on all sides, were well marked, and their size very variable. In several places the substance of the bone was rendered so opaque by dirty, brownish-yellow spots, that the corpuscles were no longer visible where the change was most advanced. The *cancelli* contained principally a dirty brownish-yellow, molecular substance.

Thus, in this case, we have a confirmation of a phenomenon, to which we shall have repeatedly to recur in speaking of new formations; viz. that, in exudations, one part may be in a state of involution, whilst another is metamorphosed into new-formations, which, on their side, again may also undergo a retrograde transformation.

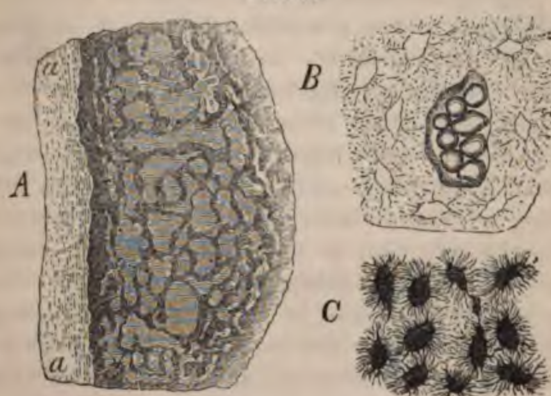
As an exudative process, also, in which the osseous substance is, to a great extent, fused, or melted away, we have here to consider the disease known under the name of *osteomalacia*. In a well-marked case of this kind, in which, except those of the head, all the bones were affected, we noticed the following condition: the bodies of the *vertebræ* were so soft as to be readily cut with a knife, the *medulla* full of blood and very fluid, contained but little fat; the separate fat-cells were far apart, and among them was a large quantity of white blood-corpuscles, and numerous groups of brownish-red pigment-molecules, derived partly from necrosed blood, partly, perhaps, from the infiltration of the finely-divided fat, with the colouring matter of the blood. The osseous substance contained light-

coloured, transparent bone-corpuscles, and the intercorpuscular substance showed a great tendency to separate into *lamellæ*, whence it presented a finely striated aspect. The *medulla* in the ribs was in the same condition as that in the bodies of the *vertebræ*, except that the collections of pigment were wanting. The marrow in the *femur* was very remarkably affected. It was of a light-yellow colour, of a gelatinous consistence, and could be drawn out into threads. The fat-cells were evidently rarefied, many of them were minute, sometimes of a rounded, sometimes of an elongated form, whilst some were of unusual dimensions. In many of the smaller fat-cells, still more minute fatty molecules were collected, enclosing an oval *nucleus*. The fat in the form of globules within the cell, and grouped around the *nucleus*, appeared to be suspended in a gelatinous and albuminous fluid. Oval *nuclei* were visible among the isolated fat-cells, which, from their size and form, appeared to belong to cells which had been destroyed. The osseous tissue of the *femur*, in a transverse section, taken from the middle of the bone, was reduced to a cortical substance, scarcely 0·22‴ in thickness, from which jagged, slender, osseous spicules projected towards the *medulla*, constituting a delicate network. The compact osseous tissue of the *femur* could be split into *lamellæ*, some of which presented no appearance whatever of bony structure, being simply structureless plates, whilst some were hyaline, and in many places exhibited opaque bone-corpuscles, according as the part was more or less advanced in its degeneration. The medullary canals had disappeared; and the polished section of bone was quite flexible. A very remarkable circumstance was presented in one of the ribs, a transverse section of which, made at a distance of four or five inches from the cartilage, displayed a glistening, greyish-white substance, about 1·77‴ in diameter, and with ill-defined outlines. This body proved distinctly, in several places, to be fibro-cartilage. The oval cells of various dimensions were lodged in great numbers, and isolated, among the decussating, rigid, fibrous bundles. This cartilaginous mass must doubtless be regarded as of new-formation, and as having been developed out of the exudation deposited in the substance of the rib. The condition of the intervertebral cartilages was also interesting. In many places, in the midst of the normal cartila-

ginous parenchyma, were contained cells covered with calcareous particles. Just as in this situation the removal of the earthy salts had not gone on, notwithstanding the advance it had made in the contiguous bones, so also had it produced no change in the forms of ossification of the cells of the thyroid cartilage and of the intercellular substance.

The exudation in the interior of the bone often leads to a *fusion of the osseous substance*, as may be witnessed, for instance, in syphilitic or tubercular *caries*. In these cases, we find, not only the portions of bone immediately around the ulcer, in a state of *infiltration*, but frequently, also, the closely contiguous bone in the same condition. We have selected as a good instance, a horizontal section of a hypertrophied occipital bone, taken from an individual affected with syphilitic ulceration on the parietal bone. Fig. 52, *A*, *a a*, represents the external,

FIG. 52.



condensed portion of the bone, with the medullary canals appearing as streaks and points. This part is of a white colour, whilst the adjacent substance is of a dirty, light-yellow hue, and (by reflected light) the expanded *cancelli* are seen as lighter coloured spaces. These *cancelli* are filled with fat, as shown in fig. *B*, which represents one of the *cancelli* of an elongated form, and in great measure filled with fat. The light-coloured bone-corpuscles surrounding it differ from the more opaque ones (*C*) filled with calcareous salts, which are taken from the external dense portion (*a a*) of the bone.

The further changes effected in the bone depend upon external circumstances and the nature of the exudation with which it is infiltrated. From the great difficulties opposed to the accurate analysis of this exudation, we must at present be satisfied with conclusions drawn from analogy, bearing in view the products arising from it. Fibrinous exudations, in particular, appear to be connected with a rapid fusion of the osseous tissue, as is seen in many, rapidly spreading, ulcerations of a syphilitic or scrofulous character; whilst thin, fluid exudations abounding in albumen, simply cause an erosion and sponginess of the bone, as in [other forms] of *caries*. These exudations, among which, probably that described in the case of *osteomalacia* should be reckoned, may, under particular modifications, afterwards become connected with a fusion of the osseous substance.

In order to study the changes exhibited in bone, in *osteitis*, Virchow properly recommends the examination of recent bones, the principal part of the alterations being lost, or at any rate rendered far less distinct, in dried and polished sections. He breaks off minute plates of bone from the inflamed part, and either places them at once entire under the microscope, or rapidly removes their earthy constituents by concentrated hydrochloric acid. In this way he has succeeded in detecting a *fatty metamorphosis of the bone-corpuscles*, indicated by the collection in the interior of the corpuscle of one or two, or of entire groups of fatty molecules. In some, especially well-marked cases, he says that he has distinguished similar fatty granules in the *canaliculi;* but in this situation they were isolated, wide apart, and far smaller. In many instances the bone-corpuscles presented the aspect of thickened cartilage-cells furnished with pore-canals.

§ 6. Muscle.

Under this head we include the infiltration of the primitive *fasciculi*, which, thence, in the aggregate, present an altered aspect visible even to the naked eye. In this affection there is no increase of the muscular substance.

When speaking of *hypertrophies* of the tissues, we were obliged to notice several pathological changes of the muscles,

connected in part with the involution of the hypertrophied primitive *fasciculi*, and in part referable to an exudation in them. Thus we spoke of *succulent* portions of hypertrophied muscular tissue, in which it is infiltrated with a gelatinous material. This morphological change is also seen in exudative processes in muscles not in the hypertrophied condition. Examination of the elementary tissues, in this case also, shows that the transverse striation is rendered less distinct, the primitive *fasciculus* being filled with a transparent homogeneous substance; at the same time, also, irregular swellings are produced apparently by an accumulation of the viscous fluid contents within the *sarcolemma*. The *fasciculi* adhere more closely together, and, in the aggregate, appear of a paler colour. In the muscular parenchyma, in this state of gelatinous metamorphosis opaque spots may be noticed, enclosing primitive *fasciculi* transformed into a fine molecular substance. Their consistence is thus so far reduced, that in some places the limits of the individual *fasciculi* can no longer be distinguished. The *sarcolemma* is so much softened by the exudation, as to be dissolved leaving nothing but a fine molecular substance, in which not a single primitive *fasciculus* can be discerned. Virchow has described the latter condition in precisely the same way, terming it *inflammatory softening*, and referring the fatty degeneration also, to it, in accordance with his notions of inflammation. We have treated of this change under the head of atrophy of muscle, since fatty degeneration also occurs without any indication of increased transudation (as for instance, in advanced age). On the other hand, however, it must be allowed, that a similar morphological change of the primitive *fasciculi*, attended with the appearance of rows of fat-globules also occurs in inflammation. This form of involution is induced, not by a diminished (as in atrophy), but by an increased transudation (exudation).

Another morphological change is produced in inflamed muscle, by the accumulation of pigment within the *sarcolemma*, as we have shown to be the case also in hypertrophied and atrophied muscle. In this condition, pigment-molecules are seen on the surface of the *fasciculus*, grouped parallel with its longitudinal axis; they lie at pretty regular distances, and are most probably disposed around the *nucleus* of the *sar-*

colemma, and consequently represent a pigmented degeneration of the elements of that membrane.

The exudation in the interstitial connective tissue of the muscle, when organizable, undergoes transformation; new connective-tissue is formed, and the nutritive material being diverted in this direction, the connective-tissue elements rapidly increase, at the expense of the elementary organs of the muscle. We have termed this wasting of the muscle, "atrophy by growth of cellular tissue."

Suppuration constitutes the second, frequent transformation of the exudation. It never occurs in the primitive *fasciculi*, but in the interstitial tissue. When the suppuration is rapid, the former undergo a process of solution.

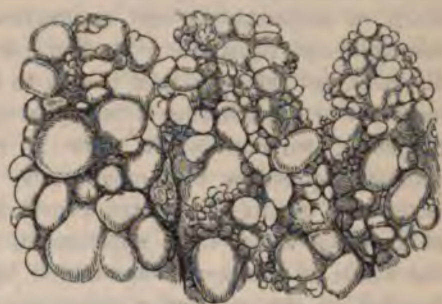
§ 7. Blood-vascular Glands.

In the thyroid gland we usually meet with exudations containing colloid, constituting the so-termed *struma lymphatica* (Rokitansky's first type of bronchocele). They are deposited in considerable quantity in the lobes of the gland, so that the latter is seen to enclose more or less extensive cavities filled with the colloid substance. The primary seat of the deposit is in the glandular vesicles. The form assumed by the colloid substance, either whilst still within the vesicles, or external to them, after their rupture, is very variable, affording as it were a cast of the cavity in which it was deposited. We meet with discoid, reniform, or more elongated, hyaline corpuscles, which, when lying exactly behind a granular cell, might cause it to be confounded with a large nucleated cell. No cell-wall, however, is ever perceptible. The outline of these transparent, floating colloid masses disappears, almost entirely, on the addition of water. The very variable form, also, and the size of these bodies are equally opposed to their being any kind of cell, even of a pathological origin.

These exudations are afforded by the fine capillary plexus which encompasses the gland-vesicles, and gradually induce a dissolution of the delicate *epithelium*, on the inner surface of the vesicle, and ultimately that of their connective-tissue tunic, so that two or several of such infiltrated gland-vesicles coalesce, and constitute cavities recognizable even by the naked

eye. The more extensively the exudation is diffused, the more is the bulk of the organ increased, and in the same proportion is its proper texture destroyed. In fig. 53, we have represented three lobules of the thyroid, containing colloid matter. The cavities, which are filled with a very viscous fluid resembling thick mucilage of gum-arabic, were of extremely various dimensions; the smallest had a mean diameter of about 0·022‴, and were usually more or less opaque; the larger reached the diameter of 0·044—0·35‴. But few blood-vessels could be seen even in the basal portions of the lobules, whilst, under other circumstances the normal thyroid is well supplied with them. The larger cysts are usually deprived of *epithelium*, and are surrounded by a fine *plexus* of straight, delicate connective-tissue filaments, which are particularly well seen in thin sections of a boiled and dried thyroid gland. The above-described structure was found to obtain throughout the diseased gland.

FIG. 53.



In the second type the enlargement of the organ is not universal, but limited to certain portions of the gland. Thence arise the well-known nodular elevations, which may reach a considerable size. In this form of bronchocele, which has been termed *struma cystica*, the same process as that above described, essentially takes place. The colloid exudation is poured out in separate groups of lobules. An important circumstance should here be noticed, that a new-formation of cellular tissue takes place around the infiltrated lobules, by which they are enclosed, as in a sort of capsule. The enclosed *colloid exudation* undergoes changes of form, which we will now submit to more particular consideration.

In proceeding to the examination, it is necessary to slit open a thickened sac of the diseased thyroid gland, and to take particles from the soft, hyaline spots on the inner surface. Forms will then be perceived, which have been explained in

various ways. Rokitansky has described and figured them correctly. They may be brought under various categories: 1. Flattened, transparent, colourless corpuscles of various dimensions, without any cell-membrane or *nucleus*. Their shape is usually round, oval, or occasionally presenting different kinds of indentations and sinuosities, and they consist of a homogeneous substance; 2. The peripheral outline is more distinct, and the substance begins to become differentiated; a narrower or wider border being apparent at the periphery of the corpuscle, surrounding it like a ring, within which the substance presents a homogeneous, hyaline aspect; 3. The latter now begins to undergo a further metamorphosis; groups of granules make their appearance, which sometimes occupy the whole of the space surrounded by the annular border; 4. Instead of the molecular substance, isolated, flattened, granular bodies, solitary or multiple, are seen in the central hyaline mass; 5. Several annular layers are formed, disposed concentrically around a, usually, granular mass.

All these bodies may also become detached from the wall of the cyst, in whose fluid they are frequently found floating. For representations of their forms we must refer to the thymus, and prostate, and to the choroid coat of the eye. Nor shall we here enter into a more precise exposition concerning them; merely noticing, that we cannot coincide in the view expressed by Rokitansky, according to whom they are adherent, vesicular *nuclei*, whose wall has coalesced with the contents, chiefly after the transformation of the latter into the so-termed colloid, in consequence of which, all farther development and growth, appear to cease. In order to explain the concentric, annular layers, he assumes an endogenous formation of *nuclei*, in which, within the enlarged *nucleus*, a second is produced, in the latter a third, and so on. We simply regard the bodies in question as, at first, homogeneous, the external, solidified substance afterwards assuming the form of an annular layer, whilst the enclosed fluid matter sometimes breaks up into a molecular substance, and is sometimes transformed into vesicular and nucleated structures. The subject will be discussed more particularly, as has been said, hereafter.

Another form of metamorphosis of the colloid exudation is that of *cretification*. It is developed on the walls of the

sacculi of the thyroid gland, and appears in the form of bony plates, usually spotted with yellow, in all respects analogous to the plates met with in the thickened *pleura* and in atheromatous vessels. In polished fragments, jagged, irregular cavities may be noticed, especially towards the bordering, cellular tissue, which it demands some closeness of observation not to confound with bone-corpuscles, and which resemble in every particular those microscopic forms in the cretified *pleura* depicted in fig. 43. Isolated groups of spherical deposits (carbonate of lime) are imbedded in the more transparent parts. Like Förster, we have never been able to observe a true ossification.

If the examination of the thickened cyst-wall be carried farther, a layer of polygonal, epithelial cells will be noticed on the smooth parts of the inner surface; at other points, a spongy, connective tissue-substance is apparent, projecting from the wall of the cyst into the cavity, and concerning which more will be said when we speak of "new-formations."

We will now mention the following, as forms of the highest interest, which were met with in a colloid exudation in the *thymus gland* of a new-born child affected with *pemphigus*. In sections across the lobes, the central portion of the parenchyma appeared to be softened, whence was produced an irregular cavity filled with a reddish-yellow fluid. This fluid contained principally *nuclei*, usually beset with a few brilliant molecules, and which after treatment with acetic acid, afforded no indication from which it could be supposed that they were any form of disintegrated pus-corpuscles. But a remarkable opacity resulted upon the addition of that acid, and streaky masses were apparent in the opaque portions (*mucin*). The parenchyma of the gland was swollen, and rendered opaque, by a molecular infiltration. But besides this, there were, also, imbedded corpuscles, remarkable by the multiplicity of their forms. These were: 1. (fig. 54, *a a*) discoid bodies of a light grey-green colour, consisting of concentric peripheral layers, and enclosing a central substance, sometimes finely molecular, sometimes containing minute *nuclei*. 2. The central substance contained elements, in part simply granular, in part furnished with a vesicular *nucleus* (*b*). 3. The granular, round corpuscles were accumulated in such abundance in the central transparent substance as to occupy it almost entirely (*c*),

FIG. 54.

the solidified, peripheral colloid substance, forming closely approximated layers, surrounding the brownish-yellow globules. 4. The corpuscles often enclosed several smaller ones of divers forms. Thus, in (*d*), we have groups of larger and smaller, nucleiform bodies, perfectly hyaline spaces, and cell-like corpuscles; and in (*e*), the layers embrace a multitude of isolated, encysted bodies, and in the lower part surround a hyaline substance containing no [morphological] elements. In (*f*) the central, enclosed bodies are of various forms, each separate group being surrounded by concentric layers.

With respect to the origin of the forms above enumerated, several possibilities may be imagined. Either the elements are first formed and afterwards enclosed by the fluid, gradually solidifying colloid substance, or the peripheral layers are formed by the solidification of the colloid exudation deposited in the interstitial tissue,—as may be observed, for instance, in a drop of solution of *gelatin*,—the central substance remaining, at any rate for a time, in the fluid condition, surrounded by the solidified outer layers, and the various kinds of elements not being precipitated, till afterwards, from the fluid *blastema*. But again, the solidification of the peripheral layers may, also, take place simultaneously with the new-formation of the elements. It must be allowed, however, that we have no sufficient grounds upon which, conclusively,

to decide in favour of one or the other mode of formation, and believe, therefore, that both the above possibilities must be admitted.

Exudations in the *spleen* are either diffused throughout its entire substance, or are sometimes confined to isolated, peripheral, well-defined spots. The fluid *albuminous* exudation, deposited in the parenchyma, in tumefied spleens so affected, may be precipitated by means of hot water; in the boiled and dried organ, therefore, fine sections may be readily prepared, exhibiting a laminated deposit of a finely granular substance (precipitated *albumen*) lying in the parenchyma. These exudations are usually accompanied with hemorrhages from the small vessels, and, for instance, in the pulpy spleen (in *typhus*), may be recognized by the large accumulation of red-brown pigment, which is deposited in the parenchyma, and remains unchanged in the alkaline carbonates. Minute *hematoidin*-crystals, also, are of not unfrequent occurrence. An exudation, mainly of a *colloid* nature, appears to occur in that form of induration known under the name of "lardaceous spleen" (Speckmilz). In minute, well-washed portions of the organ in this condition, especially in many places, numerous amorphous transparent masses will be seen, deposited in flakes, resembling the colloid masses in diseased thyroid glands, and which are not further changed upon the addition of acetic acid. Together with these, a dirty brownish-yellow pigment, in the free condition, is always present.[1]

The *genesis* of the so-termed "*blood-corpuscle-containing*

[1] [According to H. Meckel (quoted by Dr. Parkes, 'Brit. and For. Med.-Chir. Review,' vol. xix, p. 416), the spleen in lardaceous affection is *never* free from disease, although in some cases nothing may be apparent to the unassisted eye. The arterial capillaries are lardaceous, and sometimes have little lateral bulgings, especially where in connection with the Malpighian corpuscles. These bodies contain, at first, normal splenic corpuscles; at a later stage, some irregular, granular, gelatiniform lymph-corpuscles appear among them; then minute masses of lardaceous substance appear. Virchow states that the sago-like grains in "waxy spleens" are composed mainly of particles affording the reaction of cellulose when treated with iodine and sulphuric acid. He distinguishes two kinds of the affection, in one of which the cellulose-particles are contained within the Malpighian corpuscles, and in the other in the inter-corpuscular substance—a distinction, however, without much real difference, since there seems to be little or no difference, except morphological, between the corpuscles and the surrounding pulp.—Ed.]

cells" of the enlarged spleen is probably connected with this form of coagulable exudation. Many doubts have been entertained with respect to these structures, and in particular has their cell-nature been contested by several observers. They are discoid bodies which have been observed in the pulp of the spleen, enclosing from one to twenty blood-corpuscles, but in which neither a cell-membrane nor a *nucleus* can be perceived. In general they are rare; and they arise, as we consider, in islands of coagulated exudation, which, during the process of solidification, have enclosed the blood-corpuscles escaped into the parenchyma. This process may be compared with the well-known experiment, in which, after the admixture of almond- or olive-oil and blood, groups of blood-corpuscles appear, encysted, as it were, by a spherical, vesicular capsule. The cell-nature of the blood-corpuscle-containing bodies, has been shown by Kölliker and Ecker in the spleen of animals, inasmuch as they could perceive a cell-membrane and a *nucleus* in them. In man, however, these cells cannot be said to have been demonstrated, although the pigment-cells, not unfrequently met with in the human spleen, correspond with those which have been observed in several animals, associated with the cells containing blood-corpuscles, and with respect to which, it is supposed that the pigment in them originates from pre-existing blood-corpuscles. As it is certain that pigment is formed from disintegrated blood-corpuscles, so, also, has it been satisfactorily shown, especially by the more precise observations of Virchow, that the colouring matter, quitting the blood-corpuscles, enters the neighbouring parts (fibrinous coagula, cells, fibres, &c.) by imbibition, and undergoes further transformation in them; the existence of blood-corpuscles, consequently, in the cells, is not necessarily requisite for the formation of pigment in them. Moreover, lastly, it should be remarked, that Remak, upon weighty grounds, calls in question the existence of the blood-corpuscle-containing cells, in the spleen, even in animals.

Cells containing pigment occur very extensively in the greyish-black spleen, especially after intermittent fever, as has been shown by H. Meckel and Heschl; the former has also met with brownish or blackish pigment, either aggregated into masses or in cells, in the blood of persons suffering under intermittent fever.

An excessive amount of white blood-corpuscles (resembling pus-corpuscles) is found in cases of the affection first described by Virchow, under the term *leukhæmia*, in the vessels of the much-enlarged spleen.

In the peripheral, *conical deposits* of a light-red or yellowish-red colour, arranged by Rokitansky under the secondary inflammations, a considerable quantity of free fat, in the form of larger or smaller globules, which are sometimes, also, collected into extensive *plaques*, is found in the dirty, light-yellow, speckled spots. Besides which, brownish-yellow, granular agglomerations are also visible. The *trabeculæ* of the spleen are covered with the same fatty granular substance, so that, even when compressed, they will be found to have lost their normal transparency. In the yellowish streaks presented in these conical masses, the fatty infiltration of the *trabeculæ* is so considerable, that, by transmitted light, they appear even to the naked eye as opaque *striæ*. Abundant crystals of *hematoidin* are lodged in the yellowish-red spots.

§ 8. Lungs.

In the lungs, the exudation appears to follow the course of both *vascular systems*—viz., that of the *bronchial*—and of the *pulmonary arteries*. In the latter case, *true pneumonia* is established, in which the air-cells are, likewise, always the seat of the exudation. In the former a bronchial exudation is developed, giving rise to consecutive blood-stases in the system of the pulmonary artery. Since the injections of Adriani, and of Rossignol have shown that the bronchial arteries and veins may be filled from the pulmonary veins, and the latter again from the bronchial arteries, the intercommunication of the two systems is demonstrated, and disturbances of the circulation in the one system explain those which are witnessed in the other. Thus, also, in an anatomical point of view, an exudation in the ramifications of the *bronchiæ*, a so-termed "bronchial catarrh," in which the exudation more or less obstructs the canal of the *bronchiæ*, might induce a consecutive pneumonia, and the reverse.

An exudation in the interstitial pulmonary tissue, in which the walls of the air-cells are said to be mostly involved, and

occasionally even in the form of croupose pneumonia, as stated by Rokitansky, cannot, according to Engel, with whom we agree, be shown to exist; he says: "There is no pneumonia in which the interstices of the air-cells serve as a seat for the deposition of the exudation, without a simultaneous implication of the air-cells, or in which, in fact, the latter are not chiefly the seat of the effusion. The structure of the pulmonary parenchyma renders the possibility of the formation of an exudation exclusively in the interstices between the air-cells, in general, doubtful."

The *course* of the exudative process in the lungs, is sometimes observed to be limited to abruptly defined portions, and manifestly follows the terminal ramifications of the minute pulmonary arteries. A single arterial ramuscule enters each pulmonary lobule, where it ramifies in the groups of air-cells, which are disposed exactly like the *acini* of a lobate gland, and in which the cells are in all respects analogous to the terminal vesicles of the acinose glands. Since, therefore, the ramification of the pulmonary artery corresponds with the grouping of the lobules, so also does the exudation proceed in the same manner. This is most distinctly seen in exudations in the pulmonary parenchyma which have undergone such a degree of transformation, as to be distinguishable, by their colour and consistence, from the uninfiltrated pulmonary tissue. In sections of portions of the lungs thus partially affected, the latter present the aspect of consistent opacities usually of a dirty-yellow or greyish colour, whose peripheral limits are sharply defined by a scalloped border. But the exudation is often diffused throughout a greater extent of the pulmonary parenchyma, so much so, in fact, as, at last, occasionally to involve an entire lobe. In these cases also, without doubt, the infiltration of the air-cells advances according to the acinose arrangement of the latter, only more rapidly and more extensively. The examination of the surface of a pulmonary lobe in a state of nearly complete infiltration, shows that the line of demarcation is sharply defined in those situations where the diseased tissue, rendered more distinct by the metamorphosed exudation, abuts upon that still in the normal condition.

The morphological changes, exhibited in the infiltrated pulmonary tissue, depend upon the nature of the exudation, and

other concomitant circumstances. In exudations, mainly of the fibrinous character, or in croupose pneumonia, the infiltrated tissue undergoes various metamorphoses simultaneously with the transformation of the exudation, which, as is well known, have been described as so many different stages of pneumonia; for instance, by Rokitansky, as those of inflammatory congestion, hepatization, and purulent infiltration. The fibrinous exudation appears originally as a viscid fluid, tinged with blood, filling the hyperæmiated air-cells. The entrance of air, however, is still perhaps maintained, so long as the corresponding bronchial twig is unobstructed, though this period is but brief, the latter being obstructed by subsequent exudations, and thus by degrees entire lobes are deprived of their normal contents—the air,—and, when compressed, afford no frothy liquid, and sink in water. At the same time, it must not be supposed that the exudation is poured out simply in the interior of the air-cells, and on the free surface of the bronchial mucous membrane, without its also involving the interstitial tissue. In a theoretical point of view, it is not conceivable, that the exudation, which is afforded by the very close capillary plexus of the air-cells, should be deposited only within the cell, and should not also penetrate the thin wall in an outward direction. Equally erroneous would be the supposition, that the exudation is poured out only on the surface of the bronchial mucous membrane, and that the parenchyma of the membrane is not at the same time pervaded by it. Consequently there is no *pneumonia* without infiltration of the corresponding interstitial tissue, just as in *bronchitis* the infiltration of the tissue of the mucous membrane is always comprehended.

The exudation, which at the commencement of *pneumonia* is thin and fluid, being of about the same density as the blood-serum, gradually becomes more and more *viscid*, as we have established to be the general rule, and new elements begin, at once, to be developed in it.

These reiterated exudations are accompanied by minute extravasations of blood, arising from the rupture of the delicate-walled vessels, and which may be recognized in the viscid *sputa*, by the presence of a large quantity of red blood-corpuscles. Not unfrequently also, upon close examination, entire lobules will be observed, infiltrated with blood, presenting in miniature

the same conditions as are witnessed in larger portions of lung in a state of hemorrhagic infarction.

The above-noticed new elements, whose more particular description will be subsequently given under the head of new-formations, are formed in the air-cells and corresponding minute *bronchiæ*, whence they are removed by expectoration. They increase rapidly, so that both the air-cells, and bronchial branches, are wholly filled by them, and groups of the former, especially on the surface of a section, are seen in the form of granules. Thence ensues the condition termed "hepatization of the lung." The organic metamorphosis of the exudation induces a textural change in the parenchyma. The air-cells become distended, whence results a tumefaction of the portion of lung, which, owing to the absence of air, loses its compressibility, and at the same time has its density increased. The distended and infiltrated air-cells, appear on the surface of a section, as is well-known, in the form of very minute granules; but it would be wrong to attempt to explain all granular bodies of this kind as single distended air-cells, since it is easy, by the dissection of a somewhat larger granule, to show that it consists of a collection of infiltrated air-cells; in fact, it may, in general, be said that those granules whose diameter is about 0·44‴, certainly cannot be single air-cells. Even still smaller granules are occasionally met with, consisting of an aggregation of cells.

With the transformation of the exudation into pus-corpuscles, and a certain degree of *anæmia*, the pulmonary texture undergoes the change known under the name of "grey hepatization." In consequence of this alteration, the tissue of the lungs is considerably softened, so that the walls of the air-cells, and even the interstitial tissue, are the seat of softening and fatty degeneration. A manifest solution of the tissues takes place in pulmonary abscesses.

An exudation of a less plastic nature, in which the product undergoes little or no metamorphosis, is exhibited in that form of pneumonia described by Rokitansky as *catarrhal pneumonia*. A portion of the lung infiltrated in this way, does not present the granular aspect on the surface of a section, neither does it attain to the same degree of consistence as that of a hepatized lung. This disease is very frequently developed in chil-

dren as a secondary affection after a bronchial catarrh, when the affected portion of pulmonary tissue becomes the seat of a serous infiltration.

There is no such thing as a *typhoid pneumonia*, distinguished by any specific characters, whence even Engel considered it improper to assume the existence of such an affection. What is usually understood under the term, is either a hypostasis, or an albuminous or even fibrinous exudation into the pulmonary tissue, which presents an appearance differing from ordinary pneumonia, merely from the peculiar colour of the blood contained in or escaped from the vessels. Nor are there any other results, as such, independently of those proper to pneumonia in general, peculiar to the typhoid form in particular.

Serous exudations are often poured out very rapidly into the air passages, partially expelling the air. This is the case in acute *œdema* of the lungs; in the chronic form of *œdema* reiterated exudations ensue secondarily from the involution of the pulmonary tissue. To these also may be added, the thin-fluid exudations poured out in the course of *pneumonia*.

The changes which the portion of lung infiltrated with exudation subsequently undergoes, depend upon the plasticity of the latter; the most common is a collection of *pigment* in the form of reddish-brown or blackish-brown, irregular corpuscles, which originate partly from extravasations of blood, and, consequently, immediately from necrosed blood-corpuscles, partly from transuded *hematin*. Occasionally, also, blackish-brown, minute crystals of *hæmatoidin* are formed. Free *fat* occurs in the walls and among the elastic pulmonary fibres; the smaller arterial twigs, also, are covered with a large quantity of similar fat-globules, or may even, in parts, be more deeply infiltrated, nothing being visible but a flocculent material, containing fat, indistinct aggregations of *nuclei* and remains of elastic fibres, and in which the air-cells are in great measure no longer distinguishable. Calcareous particles, also, are not unfrequently met with in the pulmonary tissue undergoing involution, in consequence of the exudation.

§ 9. Liver.

In this organ also the exudations may be distinguished into the *diffuse* and the *limited;* the former extending over a considerable portion of the organ, or the whole of a lobe, whilst the latter are confined to isolated groups of lobules. The condition termed by Rokitansky "*yellow hepatic atrophy*," must be regarded as a diffuse hepatitis, in which the parenchyma of the organ is softened, in consequence of the albuminous exudation. The colour of the hepatic substance, whether dirty-yellow, reddish-yellow, or reddish-brown, depends upon the greater or less admixture of blood and bile. The most remarkable histological character of the affection is seen in the merely rudimentary condition, or entire dissolution of the hepatic cells. For in the softened parts, merely rounded *nuclei* are observable, sometimes quite free, sometimes surrounded by a group of dark-yellow, brownish-yellow, or reddish-brown pigment-molecules. Parenchymatous cells in a better state of preservation, and retaining their polygonal outline, are extremely rare, and exist, in any considerable quantity, only where the softening is less far advanced. Ultimately the *nuclei* of the hepatic cells also disappear, nothing being visible but a fine molecular substance, with aggregated and solitary, larger or smaller fat-globules. The capsule of Glisson does not yield so soon to the active process of solution, and consequently appears more distinct, in the form of streaks, although the connective-tissue fibrils of which it is constituted are likewise obscured by an interposed molecular substance. If a portion of a liver, in this state of softening, be treated with boiling water, the latter is quickly rendered turbid by the broken down and detached portions of the hepatic substance; which again is rendered so opaque that even after careful disintegration of it, nothing can be perceived but amorphous, molecular particles possessing but very little transparency. In a child six weeks old, which died, after a fortnight's illness, of *diarrhœa* and general wasting without jaundice, Dr. Bednar found about half of the liver destroyed, and presenting the appearance of a reddish-brown pultaceous mass; the capsule being corrugated and readily detached. Closer exami-

nation showed, in all essential respects, the results stated above.

In softened livers of this kind, also, may be observed, groups of ruby-red, or dark, brownish-red hematoidin-crystals, and, besides these, occasionally may be noticed, numerous black molecular masses, and brownish-black particles of *hematin*, readily soluble in carbonated alkalies (*vid. hematin*, fig. 12). Clotted, reddish-brown masses in the *parenchyma* indicate previous extravasations of blood. Another form of diffuse exudation in the hepatic parenchyma, is seen in what is termed the lardaceous liver, in which the parenchyma is infiltrated with an exudation, mainly of a colloid nature. In a well-marked instance of this kind, the substance of the liver exhibited the following characters: it was of a dirty, yellowish-brown colour, and presented on section a smooth, faintly-glistening surface, the blade of the knife not being greased; in some places the forms of the lobules were distinctly defined, and on pressure a reddish fluid was afforded in considerable quantity. Thin sections showed that the parenchyma, in indistinctly circumscribed spots, contained a flocculent material, consisting of minute, hyaline, amorphous flakes. This material was unchanged by acetic acid, and was also deposited in the well-developed *areolæ* of the hypertrophied "capsule of Glisson." The disposition of this matter was still more manifest in thin sections of the boiled and dried liver, which had been treated with acetic acid. The hepatic cells were small, their molecular contents almost wholly removed, and the *nuclei*, even after the addition of acetic acid, were not distinctly evident.

The real condition of things in lardaceous livers of this kind, which are at the same time fatty, is not so evident, the fat-globules, both within, and, perhaps also, without the hepatic cells, impeding the observation.

The transparent, amorphous masses, which we have described as of a colloid nature, are, as has been stated, lodged in the hepatic parenchyma, without inducing any solution of the cells, such as is produced by the exudation in the so-termed "yellow atrophy." In the latter, a collapse of the substance, and a diminution in the bulk of the whole organ, is produced by the destruction of the proper constituents of the parenchyma, viz. the hepatic cells, whilst in the "lardaceous" liver, owing to the

uninjurious effect of the exudation, a considerable increase of volume is observed.[1]

As a diffuse exudation also, we regard the *yellow, turgescent livers of jaundiced new-born infants.* The cut surface is smoother than usual, and the denser structure contains a viscid fluid; the hepatic cells throughout, present a gold-yellow colour, from the molecules of bile-pigment contained in them. The acute œdema of the liver also, is, of course, to be referred to the same category.

The circumscribed exudations take place in groups of hepatic lobules, which are infiltrated with a consistent, yellowish, or yellowish-green exudation. The most remarkable example of this affection is seen in the so-termed metastatic inflammatory *foci* of the liver, which are occasionally formed after previous lesions with inflammatory deposits, in other organs. The infiltrated lobules, sharply defined by their yellowish, or yellowish-green colour, often present no decided pus-corpuscles, as might be thought from the purulent aspect, but merely rounded bodies, which, from their size, form and reaction with acetic acid, can only be regarded as the remains of *nuclei* of the hepatic cells, and which frequently exhibit pigment-molecules still adherent to them. The better preserved hepatic cells, are comparatively more opaque, and more rarefied than those in the non-infiltrated parts of the organ.

Fibrinous exudations, limited in the same way, in their earlier stages, appear in the form of somewhat more consistent, dark-red, circumscribed spots in the hepatic substance.

It may now be asked, from what system of vessels are the last-named exudations in the liver afforded; whether they proceed from the capillary system of the hepatic artery, or of the portal vein? Although we are still ignorant with respect to the venous termination of the capillaries of the former system, and are consequently insufficiently acquainted with the extent of that system, still we know that a limited portion towards the periphery of the lobules is occupied by it, whilst the portal capillary system is distributed in the proper substance of the lobule. Consequently, in exudations pervading the entire thickness of the lobule, it is more probable that the effusion

[1] [On the subject of lardaceous liver, *vid.* Meckel, 'Die Speck-oder Cholestrinkrankheit' (Ann. des Charité Krankenhauses zu Berlin), 4ter Jahrg., H. 2, p. 264.—Ed.]

proceeds from the portal capillaries. This supposition is also strengthened by the circumstance that coagulation of the blood in the branches of the *vena portæ* is attended with these circumscribed inflammatory deposits.

§ 10. KIDNEY.

With B. Reinhardt, we regard the pathological change occurring in this organ in *morbus Brightii*, as a diffuse exudation in the renal substance. In this affection the exudation is not merely deposited between the *tubuli uriniferi*, but also penetrates the delicate *membrana propria* of the latter, and makes its appearance on their inner surface. The connexion of the epithelium lining the inner surface of the *tubuli* with the *membrana propria* is loosened, and it is detached in continuous portions. Being propelled towards the pelvis of the kidney by repeated transudations, it reaches the bladder through the *ureter*, and is passed with the urine. When the *epithelium* is thrown off from a *tubulus*, and the exudative process in the latter continues, the cylindrical bodies which are well known under the name of *fibrinous cylinders* are formed. These are solid (fig. 55, *a*), translucent, well-defined, elongated particles, of various dimensions, containing a thicker or thinner layer of a delicate granular substance, and in places often perfectly transparent. Occasionally, a few oval *nuclei* are seen upon them, as in the wider portion at *a*. Whether the bodies here represented, which were procured from the urine of a puerperal female affected with *albuminuria* and convulsions, deserve the name of *fibrinous* cylinders, is, perhaps, very problematical, since the coagulation of fibrin into molecules, or a molecular form of fibrin has not been demonstrated. But the confounding of these so-termed fibrinous cylinders with the *epithelium* of the *tubuli uriniferi* (or epithelium of Bellini) is a still more extravagant supposition. The latter (*a* +) presents an entire

FIG. 55.

chain of equidistant, oval *nuclei*, retained in connexion by an interstitial, molecular substance. Besides the cells thus agglutinated together, we also find, in the urine, distinct, isolated epithelial cells of various forms. Thus Virchow has remarked the three-toothed, clamp-like forms which occur after an abundant desquamation of the epithelium in *scarlatina* and *erysipelas*. They belong to the transitional *epithelium*, which in the lining of the pelvis of the kidney even in the normal condition, presents the most various shapes.

In the case above adverted to, the solitary, smooth epithelial cells were characterised by a brownish-red colour (*b*), apparent sometimes in, sometimes around the *nucleus*. In this case it was undoubtedly due to the *hematin* contained in the urine. Blood-corpuscles were contained only in small quantity in the light-yellow, rather turbid urine, so that not more than one or two were visible in the field of view at one time. These corpuscles, especially when sparingly dispersed, may the more readily be overlooked, since part of their colouring matter is removed by the urine, and their reddish hue replaced by a greenish tinge; the characteristic discoid depression, therefore, and the determinate size of the discs, should not be lost sight of. Various irregular forms of blood-corpuscles are frequently met with, and in the urine they are always isolated, never being observed to form *rouleaux*.

In order to complete the case, we would further add, that a drop of the urine, spread upon a piece of glass and dried, exhibited a wide, bluish-green border; at the same time that crystals (*f*) of a faint azure-blue colour were formed, corresponding most nearly with those of chloride of *sodium*, and manifestly impregnated with the altered colouring matter of the urine. The sediment contained urate of ammonia, aggregated into the forms *c* and *e*, together with scattered botryoidal forms (*c*). With respect to the *occurrence of the cylindrical coagula*, we would remark that the same may be said of them, as is noticed with regard to *albumen* and *blood* in the urine, viz., that, at one time, a considerable quantity may exist in all the morbid affections to which the name of Bright's disease has been assigned; whilst at another time scarcely one, or even none at all, will be met with on the most careful examination. It is a well-known fact, indeed, that the exudative processes do not go

on continuously, but intermittently, and, consequently, that intervals occur in which no exudation takes place in the kidney. The relative quantity, also, of the coagula of course depends upon the varying amount of water in the urine; they disappear, also, in alkaline urine.

The occurrence of unmixed *epithelium of the tubuli uriniferi*, or its preponderance in the sediment, indicates the commencement of an exudation, just as we observed to be the case in the mucous membranes, in which, owing to the fluid exudation, the *epithelium* is, at first, washed away in large quantities. But it is also conceivable that a simply congestive condition might be attended with an increased transudation, and, consequent upon this, by a death of the *epithelium*, a process which rapidly runs its course without any subsequent results. In fact, we actually find that, in *erysipelas, scarlatina, pneumonia*, &c., a large quantity of *epithelium* from the *tubuli uriniferi* will be discharged with the urine, and, notwithstanding this, that a rapid recovery from the disease ensues. Höfle, and several others, have observed even exudation-coagula in the urine in favorable cases of this kind. The exudation, therefore, in these instances, soon terminates, without causing any subsequent development of *morbus Brightii*.

Now, upon investigation of the more *intimate anatomical changes in the kidneys*, which, during life, give rise for a short time to the formation of cylindrical exudation-casts, and the desquamation of the *epithelium* of the *tubuli uriniferi*, as, for instance, in *eclampsia parturientium, cholera*, in the commencement of Bright's disease, &c., the following facts will be observed.

1. In many cases, even on the most careful examination, no other prominent pathological character will be noticed beyond the readiness with which the *epithelium* of the *tubuli uriniferi* is detached, so that when the surface of a section of the cortical substance is squeezed, a turbid juice is expressed, containing rows of epithelial cells, otherwise unaltered. In viewing the loose connexion between the *membrana propria* and the *epithelium* of the *tubuli uriniferi* as of pathological import, regard must be had to the degree of decomposition present, because by the latter a ready detachment of the *epithelium* might be induced, as a cadaveric phenomenon. A general and uniform infiltration of the substance of the kidney with a hyaline, fluid exuda-

tion, might possibly exist, and yet be incapable of demonstration by dissection. Nor have we succeeded, after numerous attempts at their solidification, in finding evidence of the existence of exudations in such cases.

2. *Tubuli uriniferi containing blood-corpuscles* indicate the occurrence of the rupture of vessels, in consequence of which the corpuscles escape into the canal of the *tubulus*. The mode in which this takes place will be variously explained, according to the view taken with respect to the connexion between the *tubulus uriniferus* and the capsule of the Malpighian body. If Bowman's view be adopted, according to which there is an immediate continuity between the cavity of the capsule and the canal of the *tubulus*, the hemorrhage from the Malpighian body into the latter will be readily explained, as it is by Frerichs. But if such a continuity be denied, it is necessary to admit of a rupture of the *membrana propria* of the tubule. If the propulsion of the blood-corpuscles and their expulsion from the *tubuli* are in any way prevented, they undergo a change, sometimes resembling that which is produced by the addition of dilute tincture of iodine to the corpuscles; they lose their red colour, and become of a dirty yellow, the acetabular depressions at the same time disappearing; their outline also is rendered more distinct, from the membrane being more strongly defined.

3. *A granular investment of the Malpighian bodies*, which is not visible until they are isolated, which is best done with a curved needle. In fig. 56, we have represented a convoluted vascular coil (Malpighian corpuscle), taken from the kidney of a woman affected with *eclampsia parturientium*, who died on the fourth day of the disease. The surface is covered, partly with a fine granular substance, partly with solitary and aggregated fat-globules, which were not further changed by acetic acid or carbonate of soda; being rendered, in fact, more distinct by the latter. The quantity of the deposit

FIG. 56.

varied, perhaps, in different corpuscles, but the difference was inconsiderable. In well-marked Brightian kidneys, which were enlarged, in many places hyperæmic and pervaded by minute extravasations of blood, and in others of a pale-yellow colour, and which afforded an abundant turbid juice upon pressure, we found some Malpighian bodies thickly coated with a granular fatty substance, whilst, in others, the walls of the convoluted capillary vessel were covered with a hyaline matter, by which the convolutions were glued together, and the vessel rendered indistinct. Frerichs has also observed, between the *glomerulus* and capsule, a close layer of solid fibrinous (?) exudation, of granular constitution and mixed with numerous fat-drops. In some cases, he also noticed in the capsule, rhombic plates of crystallized *cholesterin*. Occasionally, a fatty molecular infiltration of the capsules may be seen, which are recognizable, even by the naked eye, on the surface of the kidney, appearing as minute, yellowish-white points, but are not visible until the surface is viewed obliquely and under a strong illumination. Isolated corpuscles, when dissected out, consisted solely of an aggregation of larger and smaller, brilliant molecules, which remained unchanged in acetic acid. Viewed in continuity with the surrounding substance, they appeared as oval bodies of pretty nearly uniform dimensions with sharply defined outlines, and containing, besides the granular fatty substance above mentioned, which was often collected towards one point of the corpuscle, a structureless hyaline material. These corpuscles, though less distinctly, were also visible in the interior of the kidney. It is remarkable that in none of them were remains of the *glomerulus* to be found, and, consequently, the main reason for supposing them to be infiltrated Malpighian corpuscles is wanting, though, nevertheless, from their size, form, and uniform distribution, we think they must be regarded as such. F. Simon, also, states that he has seen the vascular coil forming an irregular, contracted mass at the bottom of the capsule, a circumstance indicating the partial solution of the *glomerulus* within the distended capsule.[1] At the same time, we are far from thinking that in every diffuse, renal inflammation, such a remarkable

[1] [*Vid.* Toynbee, on the Intimate Structure of the Human Kidney, 'Med.-Chir. Trans.,' 2d ser., vol. xi, p. 320.—Ed.]

fatty metamorphosis of the contents of the capsules takes place, but, on the contrary, consider that in most cases a solution of the Malpighian body is brought about by the fluid exudation.

4. *Fatty degeneration of the cell-contents of the epithelium in the tubuli uriniferi* is of constant occurrence when the *morbus Brightii* has reached a certain stage. The drawing shown in fig. 57, is taken from the kidney of a woman who was attacked by cholera, had bloody *diarrhœa*, fell into the typhoid state, and died on the tenth day after her admission into the hospital. The kidneys were swollen, pale, of loose texture, especially in the cortical substance, and afforded, on pressure, a milky fluid; lighter-coloured streaks, also, extended into the medullary substance. Groups of *tubuli uriniferi* in the cortical substance were entirely crammed with fat-globules, as in fig. 57, *a*, in which is seen, below, the *membrana propria*, as a transparent folded membrane. The fat-globules in *b*, appeared of a smaller and more uniform size, and in many places were so closely packed, that the tubule was there rendered perfectly opaque. The canal of the tubule was wholly occupied by the accumulated fat, as is shown at *c*. When the *epithelium* was subjected to more minute examination, for which a drop of the turbid juice served, the intermediate stages of the fatty degeneration of the cells could be readily traced, as at *d*. Isolated fat-globules appeared between the *nucleus* and cell-wall, and were soon so multiplied as completely to conceal the former, which, together with the wall, was destroyed. Thus, in place of the epithelial cell, there was only an agglomeration of granules. From many of the lighter-coloured *tubuli uriniferi*, hyaline, tubular bodies, beset with fat-drops, could be expressed, which might be regarded either as remains of the dissolved *epithelium* or as a solidified exudation. Lastly, in several groups of *tubuli*, imperfect,

Fig. 57.

brownish-yellow, crystalline forms of uric acid (*f*) were deposited.

The fatty degeneration of the *tubuli uriniferi* always commences in the cortical substance, and is manifested, even to the unassisted eye, by the yellowish appearance of their bundles. If, for instance, a well-marked "granular" kidney, as it is termed, be taken, and the closely approximated, light-yellow granules apparent on the surface of the organ be subjected to examination, each of them will easily be seen to consist of an entire packet of *tubuli uriniferi* in a state of fatty degeneration, which, owing to their fatty contents, appear dark by transmitted, and of a bright, light yellow, by direct light. The granular aspect is produced by the stronger bundles of connective tissue, and by the vessels, by which, in the normal condition, entire packets of tubules are encompassed. The medullary substance, when the *epithelium* of its tubules is in a state of fatty degeneration, presents a yellow striation corresponding with the disposition of the canals.

We have also observed fatty degeneration of the *epithelium* in the kidneys of an individual affected with *melituria*. The organs were enlarged, and the vessels surrounding the packets of *tubuli uriniferi* injected, whence the surface of the cortical substance presented a granular aspect. The texture in that situation was so much softened, that the *tubuli* could not be drawn out to any length, breaking off in the dissection. Many of them were entirely filled with fat-drops, and the expressed epithelium was in the most advanced stage of fatty degeneration. The softening of the substance was also manifested in the readiness with which the Malpighian bodies were torn asunder; even the pyramids had lost their normal consistence, especially in the basal portions. A turbid, mucoid fluid could be expressed from the papillary processes, containing the readily detached epithelial cells of the straight canals of the tubular substance.

Several writers have assumed that the *tubuli uriniferi* are enlarged, owing to the accumulation of the exudation within them; and Frerichs regards this distension of the *tubuli* as the principal cause of the enlargement of the gland. Direct measurements alone can decide this point, and its determination will require the greater caution, since the size of the *tubuli*

uriniferi varies very much, and even in the normal condition, some may be observed of considerable dimensions. At present, precise *data* are wanting with respect to the increase in dimensions of the *tubuli uriniferi* in the exudative affections of the kidney. It might be considered probable, *a priori*, that the tubules may be distended up to a certain *maximum* by the infiltration, and then give way; but their hyaline *membrana propria* is, perhaps, hardly capable of any great degree of extension. At the same time, it should be noticed, that there is a source of error in the observation, which though obvious, may still very readily be fallen into, viz. that a partially overlapping loop of a tubule may be taken for a dilatation of it.

5. *Extravasations of blood* take place very frequently in the albuminous exudation of the kidney, presenting the appearance of irregular, minute, red points; they usually occur scattered in the cortical substance, being more rare in the tubular portions of the gland, where they present the appearance of elongated, irregular, bloody streaks. The extravasated blood soon loses its vitality, and forms reddish-brown masses.

6. The *solution of the glandular substance* induced by the exudation, commences at the periphery of the cortical substance, in such a way, in fact, that separate groups of contiguous *tubuli uriniferi* collapse, whence is produced a minute, shallow infundibuliform depression, known as a "cicatriform" contraction of the cortical substance; the same process may also take place in several, contiguous peripheral groups, when a shallow depression is produced, not unlike the cicatrix of an ulcer with an elevated, callous border. Upon closer examination, the shrunken *tubuli uriniferi* filled with a dirty, brownish-yellow material, as well as the Malpighian corpuscles, reduced in size, may be discerned, the interstitial cellular tissue, consequently, even when not hypertrophied, being rendered the more distinct.

7. The albuminous exudation in the course of Bright's disease, usually passes into one of a well-marked *colloid nature*. Even in the stage of infiltration, perfectly hyaline, smooth masses of various forms and sizes are frequently met with in the divided renal substance, resembling the structureless, transparent, dull-bordered, smooth masses, from the colloid thyroid gland. In the chronic forms of Bright's disease, and,

particularly, in well-marked fatty kidney (under which term he understands the fatty degeneration of the *epithelium* of the *tubuli uriniferi*), Lehmann describes hollow cylinders with plicated walls so transparent as to be best rendered visible by the use of the stop in the microscope. He regards them as the *membrana propria* of the *tubuli uriniferi*, and warns us against the confounding of them with the croupose fibrinous cylinders (?). The hollowness and the plication would thus distinguish the bodies found by Lehmann in the urine, from those which are met with in the substance of the kidney.

In the case of reiterated (chronic) exudations in the kidney, the colloid masses undergo all the morphological changes that are found to occur in other organs, and which, as regards the colloid exudations of the thyroid gland, have been placed in different categories. As a special form, it is necessary to notice one which we would designate as the *radiating colloid bodies*, and which also exhibit a very remarkable difference in their constituents. They form a part of the contents of the cysts of atrophied kidneys, and have been met with, by us, only a few times, in aged individuals. We distinguish the following forms: 1. Flattened, rounded bodies (*vid.* fig. 58, *a*) of various sizes, and about 0·008—0·02‴ in diameter, presenting streaks radiating from the central point, and of a light-grey or yellowish colour. 2. These radiated bodies are surrounded with a clearer border containing a spotted substance. 3. When the border is wider, segments of rays are observable in it (*c′* in *c*), which are not, however, in any direct connexion with the rays of the central body, but separated by a distinct line of demarcation. In the middle of these voluminous, usually brownish-yellow bodies (*c*), the central, granular, enclosed mass is more distinct. 4. To the three layers of the last-described body, there is superadded in *d*, an external, transparent, enveloping layer, in the form of an annular border (*d′*); and in the centre is seen a larger, punctated layer, into the periphery of which the rays are inserted. 5. The fourth exterior layer only partially surrounds the radiated body, in

Fig. 58.

whose centre two granular spherical masses lie, which serve as a point of insertion for the rays (*e*).

Besides the above principal forms, others of every variety of modification are also met with. In the friable, gelatinous masses in the cysts also, are found smooth, amorphous, hyaline, jagged, and flexible plates deposited in several superimposed layers, and thence acquiring a yellowish-brown colour; these plates are not further altered by acetic acid, and should in no way be confounded with disintegrated tables of *cholesterin*. In our opinion, they are masses of colloid which have coalesced, and become solid.

In the radiated, colloid corpuscles, is indicated a differentiation of the organic substance, proper to self-organizing elementary bodies, except that in this instance the separate organic parts undergo metamorphoses which do not correspond with the cell-formations in the human organism. The radiate arrangement is in a form different from those seen in the metamorphosis of cell-contents, and must, consequently, be regarded as a peculiar pathological change of the latter, in which they are cleft by radiating fissures, the *nucleus* gradually increasing into a granular sphere, which, as in *e*, may itself be capable of division. But then, how are the layers *b′*, *c′*, *d′*, to be explained ?. Are they not formed until afterwards by deposition on the radiated body, or does the body exist *ab origine*, and are the layers formed by a differentiation of the peripheral and central substances ?

In describing the colloid exudation of the *thymus*, we have indicated certain elements encysted in the colloid masses, and at the same time pointed out the possible modes in which they might be formed, without declaring ourselves definitively for one or the other, viz., whether the investing layer is formed before, after, or simultaneously with the enclosed cells. Nor, also, in the instance of the radiated colloid bodies, do we think that any definite law of formation can be laid down, but hold it, in general, as more probable, that the investing layers arise subsequently, and undergo a radiating cleavage as *c′* in *c*, having previously represented simply a hyaline layer, as *b′* in *b*.

On the other side, these radiated colloid bodies might be considered as being, originally, discoid masses of blastema, in which the central portion is precipitated as a granular sub-

stance, and from which a hardening of the organic matter proceeds, in the course of which process the solidification is effected precisely after the type of radiating, acicular crystallization.

From what has been observed on the subject of the so-termed lardaceous spleen and liver, it might be thought that a similar anatomical change would also obtain in the *lardaceous kidney*, and that the solid, dense consistence, conjoined with the remarkable deficiency of blood in the organ, might also depend upon its infiltration with colloid substance. We have not as yet been fortunate enough to arrive at any satisfactory evidence of such being the true nature of the case in the "lardaceous" kidney. Thicker or thin sections exhibit nothing whatever of an abnormal nature. Portions of kidney, thus affected, were boiled for a short time in water by which the consistence was rendered somewhat more dense, and, when dried, readily allowed thin sections to be made with the unsupported hand, which were treated first with dilute acetic acid, and afterwards with a dilute solution of carbonate of soda. Although the structure of the kidney was thus remarkably well displayed, no abnormal appearances whatever could be discerned.[1]

Of circumscribed exudative processes in the kidneys, the most remarkable are the *fibrinous*, which are well known under the name of metastatic deposits. In exemplification of the more intimate nature of one of these deposits, we will cite an instance, in which, as usual, it was situated in the cortical substance, insinuated in a wedge shape between two pyramids; it was of a lightish-yellow colour, of firm consistence and abruptly defined. The renal tissue abutting upon it constituted a dark, blood-red border composed of ecchymosed spots, and exhibiting a coarse vascular injection. The *tubuli uriniferi* and Malpighian bodies in the infiltrated spots were collapsed, and between them a material was collected, sometimes of a lighter, sometimes of a darker, brownish-yellow colour, in the form of irregular, rounded, granular bodies, whose colour was unchanged by acetic acid; the *fibrin* also was imbued with a yellowish-brown colouring matter. Free fat in the form of globules was collected in groups between the layers of fibrin,

[1] [H. Meckel (loc. cit.) notices a peculiar deposit occurring in "lardaceous" kidneys, which he terms "speck-kalk." This is probably merely an oily matter containing some earthy or uric salts.—Ed.]

and granular fat-globules (so-termed granule-cells ?) in comparatively small numbers. Deposits of amorphous, calcareous salts seemed to be also present only in small quantity. Ruby-red, very minute hematoidin-crystals were seated on the bloodless Malpighian corpuscles, and contiguous groups of similar crystals were also met with among the *tubuli uriniferi;* they were rapidly dissolved under the influence of the carbonated alkalies.

These metastatic collections subsequently assume a puriform aspect, inasmuch as their colour presents a bluish-green tinge. But in these compact portions, apparently infiltrated with pus, no proper purulent elements are ever met with, viz., the so-termed pus-corpuscles.

When these fibrinous deposits undergo involution, the mass shrinks, owing to the absorption of its fluid constituents, the fibrinous substance, containing *olein* in a state of minute division, pigment, and calcareous salts, being left.

They arise, as Rokitansky has shown, as dark-red, indurated, infarcted portions of very various dimensions, and become gradually discoloured into a dirty-brown, yellow, and yellowish-white substance.

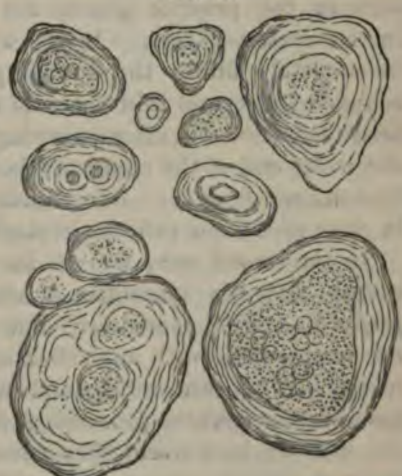
Their mode of formation as infiltrations, sometimes of the size of a pin's head up to that of a walnut, and their conical form, the base of the cone being towards the surface of the cortical substance and the apex turned towards the pyramids, are connected with the mode of distribution of the vessels in the normal condition. For we know that the branches of the renal arteries run between the pyramids towards the cortical substance, subdividing into capillaries between each pair of pyramids. The capillaries are distributed to groups of the *tubuli uriniferi;* and in this way, as many distinct systems of capillaries are formed as there are groups of *tubuli.* Now if the exudation take place only in a small system of the capillary plexus, the millet-seed deposits are produced; but if it be effused throughout a large system, as, for instance, between two pyramids, we have one of the conical infiltrations.

§ 11. Sexual organs.

With respect to these, we shall confine ourselves to a few observations, noticing, in the first place, those bodies found in the, usually, enlarged *prostate* of aged individuals, known under the name of *concretions*, or *calculi*, an appellation which is inapplicable to many of them, as we shall at once proceed to show.

In the usually dilated ducts of the indurated and enlarged prostate, there are frequently lodged, greyish-yellow, yellowish-red or reddish-brown bodies, which, when of larger size and darker colour, are apparent even to the naked eye, as minute, isolated points, on the surface of a section of the gland. They are readily crushed by pressure with the blade of the knife, and even in one and the same preparation usually exhibit very many varieties of shape. We have collected these in fig. 59. The size extends from 0·0088‴, to as much as 0·44‴, or even 1·77‴, or more. The principal character of a series of these bodies consists in their exhibiting a *peripheral, concentric striation*. The concentric layers resembling those of the starch-grain, are, frequently, only very few in number, though often ten or more may be counted. Many of the *lamellæ* are distinguished by their regularity and sharp definition, whilst many are placed at unequal distances apart, and represent interrupted, concentric markings. The central portion consists either of a molecular substance, or contains, in the latter, one or several, rounded, molecular spherules, in size resembling pus- or mucus-corpuscles; but sometimes, also, nucleiform elements are enclosed.

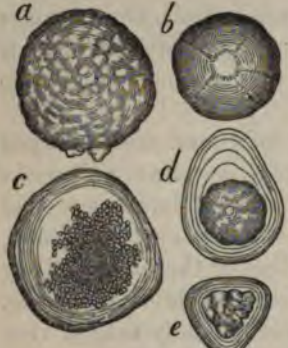
Fig. 59.



The *central, encysted portion* may also consist of *inorganic*

parts. The fine, arenaceous, pale granules which lie scattered in the *parenchyma* are nodular forms of calcareous salts (fig. 60, *a* and *b*), having a rounded form, and exhibiting, on all parts of the surface, minute, tubercular elevations, or, perhaps, appearing polished, and marked with symmetrically arranged, dark, radiating streaks. These bodies resemble, in all respects, those which are met with in the sand of the pineal gland; and are also, as when embedded in any other organic parts, rendered more distinct under the action of alkalies, since they are themselves unaffected by those reagents, whilst the surrounding tissues are rendered pale. They are soluble in acetic acid, with the occasional disengagement of air-bubbles. These calcareous salts in the prostate gland, are also met with enclosed in concentric layers. In *c*, we observe a granular mass, incompletely filling the central part of the corpuscle, surrounded by several thin layers of concentric *striæ*; in *d*, is represented a nodular, calcareous conglomerate, lying more towards the wider end of the elongated body, and surrounded by fine, well-defined *lamellæ*. In *e*, these are also well defined, and in close apposition with the central botryoidal substance.

FIG. 60.



In the second row, we see the same bodies as in fig. 59, except that the concentric lamination is wanting; they are *perfectly smooth*, more rare, and unlike the laminated form, not impregnated with any yellow or yellowish-brown, colouring matter. They are softer, and when compressed, are easily fissured, the fissures proceeding from the periphery towards the centre; in a word, they resemble in all respects the indurated colloid masses, met with in the so-termed *struma lymphatica*.

Before proceeding, in accordance with what has been stated, farther into the *nature of these concentric structures*, we shall merely premise that no change is remarked in them upon the addition of acetic acid and of dilute sulphuric acid; carbonate of soda renders them pale and they are also distended by the same

reagent. Hassall, according to a letter from Dr. Letheby, states that they are gradually dissolved in strong acetic or hydrochloric acid, and more rapidly when heat is applied; a *residuum* being left, consisting of numerous fat-globules, and the remains of cells. Carbonate of potass and caustic ammonia, according to the same observer, do not dissolve them. They are carbonized under the blowpipe, leaving only a little earthy *residuum*. According to Virchow, these prostatic-concretions, as they are termed, are composed of a semi-soft substance, behaving towards reagents like one containing protein; and upon closer investigation, he states that he finds them to be derived from a peculiar, insoluble protein-substance, mixed with the *semen*.

Hence it is obvious: 1, that these laminated structures are principally composed of an organic substance, and, consequently, that the names of "stones," and "concretions," are inappropriate to them; and, 2, that since, in their sometimes smooth, sometimes concentric form and their behaviour towards reagents, they approximate, for the most part, to indurated colloid masses, they might therefore be termed *concentric colloid-corpuscles*.

Just as it is probable that pre-existing, organic elementary parts are encysted by the fluid colloid substance exuded on the inner surface of the dilated gland-ducts, and as it is evident that, as in fig. 60, the above-described calcareous conglomerates are invested by the same fluid, so also it can not be denied, *a priori*, that it is possible for the outer layers in the exuded masses to solidify, whilst the internal, still fluid matter, may afford origin to cells which will, consequently, be only of secondary formation.

These concentric corpuscles are met with especially in old individuals, in whom colloid exudations in general appear to be frequent; they are seated, not merely in the irregularly dilated ducts in the midst of the *parenchyma* of the prostate gland, but also occur in the central extremities of the excretory ducts towards the *urethra*. When these bodies exist, the prostate is usually enlarged; and together with them we occasionally also meet with hyaline, voluminous colloid-masses, in the dirty brownish-yellow fluid of the *vesiculæ seminales*.

Albuminous and fibrinous exudations on the inner surface

of the *uterus* in the puerperal state, afford a frequent subject for investigation. The frequency of their occurrence appears to be connected with the involution of the substance of the *uterus*, which takes place at this epoch in the normal condition. According to Heschl's statements respecting the condition of the human *uterus* after parturition, the proper substance of the organ undergoes such a complete transformation into molecular fat, that of the *uterus* as it existed before parturition, not a single fibre (?) remains. The fatty molecules are often accumulated in the contractile fibre-cells, in such a way that a whole series of the latter fill the cell, and conceal the *nucleus*. The vessels also, and connective tissue, retrograde in like manner. According to this observer, the place of attachment of the *placenta* undergoes a rather more prolonged retrogression, which is probably due to the greater thickness of the wall in that situation. It is necessary to be acquainted with these normal forms of involution of the uterine substance after parturition, that we may not regard them as produced by any kind of parenchymatous inflammation; an error which may very readily be fallen into, if, as is done by Virchow, the degenerative character of the elementary parts of an organ be placed in the foreground in inflammation, and at the same time, regard be not paid to the exudation and its metamorphoses, as indispensably necessary anatomical elements for the determination of the existence of inflammation.

The organization of the exudation is limited, in this situation, only to the formation of pus, or to the new-formation of, usually large, connective-tissue cells of all varieties of form, and is to be sought for especially at the site of insertion of the *placenta*. In many cases, however, the exudation undergoes no further organic metamorphosis, nothing remaining but a fine molecular matter; and at the same time also, a rapid solution of the internal uterine substance is set up, loose *flocculi* of which project into the cavity. Close examination of these shows connective-tissue fibrils, which are so covered with a brownish-yellow molecular substance, that the wavy fibrous bundles are discernible only at the edges; the organic muscles are beset with pigment-molecules; their elongated, characteristic *nuclei*, rounded at each end, float about in numbers in the fluid; and the walls of the blood-vessels are collapsed, and of a

brownish-yellow colour. In other cases, in which the exudation and the infiltrated portions of tissue are not subjected to such a rapid decomposition, attended with putrescency, an oleaginous substance forms the principal constituent. The fatty metamorphosis in these cases, is set up with great rapidity in the affected uterine substance, and numerous groups of aggregated fat-globules make their appearance. Local infiltrations on the inner surface give rise to elevations marked with dirty-grey, yellowish or reddish spots, which, when the necrosed portion of the tissue is thrown off by subsequent exudations, give place to ulcerated depressions.

The fibrinous deposits in the *placenta*, which frequently occur, as is well known, in the form of tuberous closely adherent cap-like growths, of a sulphur-yellow colour, situated upon its convex surface, or as striped bands on the borders and concave aspect, we must, in opposition to others, such as Scanzoni and Jäger, who consider them as arising from extravasations of blood, regard as exudation-products, for, in the first place, they extend along the course and distribution of the vessels, inasmuch as the fibrinous deposit takes place around the lobules or lobes (*cotyledons*) of the *placenta*, or along the course of a vessel, as of the annular vessel; and secondly, because the closer anatomical examination of the deposit, shows nothing in favour of its being an extravasation, the principal constituents of which it is composed being coagulated fibrin, containing imbedded in it, new-formed organic elements, usually in a state of fatty degeneration, whilst necrosed blood-corpuscles are absent. It is thence self-evident, that as in most exudations, so in these, ruptures of the smaller vessels may occur, although the quantity of extravasated blood does not stand in such a proportion to the quantity of the fibrinous deposit that the coagulated fibrin can be referred to the amount of blood extravasated.

When the fœtus has been dead for some time, *gelatinous exudations* almost invariably occur on the concave surface of the *placenta*; they are deposited principally around the larger arterial branches, and give rise to new formations of connective tissue. These exudations belong to the fibrinous class, and are characterised simply by a more considerable admixture of serum.

Exudations in the *parenchyma* of the placenta rarely assume the *diffuse* form, and cause the death of the fœtus. In this

condition, the substance of the organ is swollen, the individual lobes bulging so as to render the fissures more apparent than natural; the consistence is more compact, exactly resembling that of a hepatized lung; and some parts are of a dark-red colour (loaded with blood). The *villi* adhere so closely together that it is impossible to separate them from each other with the needle, as usual; at the same time, they are readily lacerated. In the infarcted portions, imbedded molecules may also be remarked, upon dividing the lobules. The same kind of adhesive exudation may be confined to smaller portions, and it occurs thus, more frequently than in the diffuse form.

The morphological changes, undergone by the *villi* and their peduncles in parenchymatous exudations in the *placenta*, also consist, essentially, in the same forms as we have noticed in speaking of atrophy of the *villi;* and, consequently, it is only the presence of the exudation which will enable us to decide whether the atrophy be substantive, or one caused by the exudation; and, consequently, whether the involution of the elementary parts is produced by the abstraction of nutriment, or by a disproportionately abundant supply of it. Instances of indubitable *exudation in the villi* are exhibited in the forms shown in fig. 61. In the enlarged *villus, a,* the walls of the

Fig. 61.

capillary plexus are covered with a dense accumulation of minute, brilliant molecules, and are manifestly, therefore, in a state of degeneration. The same thing is seen in the less enlarged *villus, b.* The *villus, c,* with a lateral process, presents

a peripheral, wide, clear border, whilst the interior, dark, granular portion indicates a degeneration of the entire substance of the *villus* ; and the dark streak in the middle belongs to the central recurrent vessel visible in many of the *villi*, and which is also in a state of involution. In this instance, which represents the placenta of a *fœtus* at 6 months, besides the above-described atrophied forms of the *villi* (their being filled with a molecular substance), others existed in which the necrosed blood in the capillaries was metamorphosed into a brownish-black pigment (*d*).

§ 12. Brain and Spinal cord.

Exudations in these organs are either diffuse, and at once productive of deleterious effects, or are limited to separate portions, and run a chronic course. The presence of the former, diffuse exudations, however, is occasionally very problematical, in the absence of any anatomical indication. Among them, perhaps, might be ranked the so-termed "yellow softening" of the brain. Rokitansky does not regard this change as a proof of inflammation, adducing the following reasons: 1. Neither in the primitive nor in the secondary, softened parts, and in no stage of the process from the moment when its nature is just recognizable, do injection and redness exist, nor is anything of the kind to be perceived around the softened portions, either far or near. 2. Nor does it afford the usual products of inflammation, nor any elementary formations. In answer to which, it might be objected, that injection and redness, in parenchymatous inflammation of the brain in general, are less manifest, than they are in most other organs, and that we also see, as for instance, in serous and mucous membranes and several other parts, thin sanious exudations without any visible, subjacent vascular injection. The latter condition, moreover, is by no means necessary for the occurrence of this effusion, inasmuch as the increased transudation might, perhaps, be afforded by the circulating blood. With respect to the second reason, it should be remarked that the yellow, softened substance is coagulable by heat into a molecular mass, and that groups of fat-globules (granular corpuscles) are found in it. We consider it therefore as the more probable supposition, that the yellow softening is not a decom-

position of the cerebral substance, but depends upon an exudation into the parenchyma of the organ, in which are enclosed detached fragments of the cerebral substance.

A diffuse exudation appears to us to take place in traumatic *tetanus*. Several observers have found the nerves, at the seat of injury, covered with exudation, and beyond that point, have noticed a rose-redness of the *neurilemma*, without any appreciable products. We have recorded the case of a man who died with symptoms of *tetanus* on the twelfth day after receiving a crushed wound of the little finger, for which amputation was performed. The branches of the ulnar nerve in the palm of the hand were imbedded in a dirty-grey exudation. This consisted in great part of a molecular substance, containing also a few groups of immature new-formations of connective tissue. The slate-grey colour of the exudation was caused by a blackish-yellow, granular, free pigment, deposited only in a few spots around vesicular *nuclei*. The ulnar nerve, examined higher up the arm, contained a good deal of blood, and, under a lens, the *vasa nervorum* could be distinctly traced for some distance, but no product could be detected in the cellular sheath upon the closest examination. Transverse sections of the cervical portion of the spinal chord made in the part corresponding to the brachial plexus, exhibited a decidedly greater degree of redness of the grey substance than was apparent either above or below that point. But beyond this, no other textural change could be perceived. The existence of an exudation might be deemed possible in this case, notwithstanding all anatomical proof of it was wanting, which perhaps might be afforded by better methods of investigation. So long as the exudation pervades the tissue, merely in the form of a hyaline material, it escapes observation, and it is not until solid particles in the form of molecules, fibrinous clots, *flocculi*, or new-formed elementary organs are developed in the protein-substance, that we have any histological indication of its presence, except in cases where it exists in such quantity as to produce manifest swelling and infiltration of the affected tissue. It should, we think, here be remarked, that in *tetanus* the investigation of the walls of the minuter blood-vessels has attracted too little attention. It would be as well, for instance, to look for the same exterior covering of brilliant molecules, which we have shown to exist

in the Malpighian *glomeruli* of the kidneys, at the commencement of Bright's disease.

Coagulated *fibrinous exudations* on the free surface of the *arachnoid*, and on the *ependyma* of the lateral ventricles (especially on the latter), are more rarely met with, than pseudo-membranous coagula of a gelatinous, or of a more dense consistence, spread over a considerable extent of surface. They consist of a fine, filamentous network, visible only with the aid of high magnifying powers, such as is found in coagulated fibrin, and which is infiltrated with a serous fluid, from which occasionally a fine-granular, molecular substance is precipitated. These exudations on the *arachnoid*, speedily take on a high degree of organization.

The coagulation of a, probably, fibrinous exudation in the brain and spinal cord produces, when considerable, the callous transformation of the tissue, denominated "*sclerosis*." Close examination shows, that in the more indurated parts, the firm consistence depends upon a filamentous stroma, but of so delicate a nature, and so close a texture, as not to be visible except in very thin layers. The filaments are straight (wavy fibrous bundles are never seen), decussating with each other at all angles, and disposed in contiguous sets; they are of immeasurable tenuity. The interstices of this stroma are occupied by a considerable quantity of molecular substance, sometimes aggregated into little, coloured masses. In these highly-condensed spots, the nerve-tubes are wholly destroyed, and sometimes not a particle even of nerve-fat, in the form of the well-known, double-bordered, irregularly shaped corpuscles, can be expressed in a dried section; sometimes it may be seen, in small quantity, collected into groups of molecules. The blood-vessels are the more rarefied in proportion as the *sclerosis* is more advanced.

Since the question, whether this filamentous framework represent coagulated fibrin, or the sheaths of nerve-tubes simply emptied of their contents, could not be decided even by reagents, we have considered the fibrinous nature of the framework as problematical.

Albuminous exudations, in the form of brownish-yellow molecular masses, constitute the well-known opacities and thickenings of the *pia mater*, and are the cause of the intimate

adhesions constantly found in lunatics, between the latter and the cortical substance of the brain, in which the nerve-tubes and ganglion-cells are destroyed. The blood-vessels appear empty, and are covered with a fine-granular or pigmented substance in greater or less quantity.

In the *red-softening*, as it is termed, which is an inflammatory affection of the cerebral substance, an exudation is poured out, possessing but little plasticity and organizability; it soon degenerates into a fatty, molecular material, inducing at the same time a solution of the affected cerebral parenchyma. Numerous minute effusions of blood from the softened vessels accompany this process, to which the red colour is due.

The encephalitic deposits are manifested, in very thin sections even to the naked eye, by a greyish opacity, when viewed by transmitted light, whilst portions of cerebral substance squeezed between two glasses always retain a certain degree of transparency. Microscopic elementary analysis shows, in the first place, fat in a state of minute division, and presenting sometimes the form of isolated, smaller or larger, strongly refractive, dark-bordered globules, unaffected by acetic acid and alkalies; sometimes that of granular aggregations. It forms, also, the principal constituent of the granular corpuscles, a new-formed element (*vid. supra*, "granular corpuscles"), and invests the outer surface of the walls of the vessels with a thick covering. *Cholesterin* occurs chiefly in portions of older date, already in a state of involution, and may readily escape notice in the greyish, opaque substance. When accumulated in larger quantity, it may be recognized even by reflected light, with the aid of a powerful lens, by its iridescent colour, a phenomenon which we have already stated to depend upon the interference of the rays of light. It usually occurs in the form of rudimentary, jagged cholesterin-plates, whose nature, in the absence of better marked specimens, is ascertained by their dissolving in ether. The circumstance, also, of their being unaffected by alkalies and acids, must be borne in mind, which will serve to distinguish them from a solidified protein-substance.

In the cerebral substance in a state of red-softening, as has been said, there are always found minute, apoplectic effusions; in this affection, consequently, the extravasated blood undergoes

the various kinds of metamorphosis proper to that fluid when in a state of involution or deprived of vitality. The coherent, red corpuscles shrink up, but without losing their colouring matter, appearing, on the contrary, of a deeper red colour than when fresh. They assume the form of orange-yellow or reddish-brown masses, consisting usually of from about eight to ten coalescent granules, and not unfrequently surrounded by an investing membrane. The pigment is precipitated from the *hematin* held in solution in the exuded fluid, in the form of a deep orange-yellow, brownish-red, or blackish-brown matter, sometimes in that of coloured molecules, or of opaque amorphous plates.

The nerve-tubes and ganglion-cells in the site of the effusion are wholly destroyed; the vessels may still be recognized by the fine-granular material with which they are covered, and may also be distinguished by their mode of branching. The scattered bundles of connective tissue sometimes seen, appear to belong to the external coat of the smaller arteries and veins.

In the brain and spinal cord, especially of aged persons, we have frequently met with scattered, discoid, oval, or, more rarely, elongated corpuscles of a pale grey colour with a tinge of brown, measuring about 0·004—0·008‴ in diameter, and consisting partly of a perfectly homogeneous substance, partly exhibiting a concentric lamination, and thus resembling the *corpora amylacea* described by Virchow and Kölliker as found beneath the *ependyma* of the lateral ventricles. Many of them present a nucleiform body in the centre. They are not perceptibly affected by acetic acid, nor by ether, whilst a solution of potass causes them to disappear very quickly. The structureless bodies might be very readily confounded with fat-globules, but when closely examined differ in the circumstance that in the first place their border is not so sharply defined as that of the latter, and that they do not possess the same refractive properties; the second form is at once sufficiently characterised by the laminated appearance, usually consisting of 2—3 concentric rings. According to what has been said, we believe that these bodies should be ranked with *colloid corpuscles*. Those furnished with a central *nucleus*, would, as regards their mode of formation, have the same import, as that which we have assigned above, more at length, to the colloid-corpuscles in the prostate gland and *thymus*.

They must be regarded as indicative of an augmented colloid transudation, which, as we have seen in the case of otherorgans, may take place without any signs of *hyperæmia*.

§ 13. The Eye.

F. Strube, under Virchow's directions, has subjected the *cornea* to the most various inflammatory irritants, and particularly to the most active caustic applications, and closely investigated the textural changes thence produced. These consisted, in the first place, of swelling, enlargement of the corpuscles, the formation in them of minute fatty molecules, and the multiplication and enlargement of their *nuclei;* the intercellular substance became clouded or even opaque, denser, and fibrillated, acquiring a more fibrous constitution, similar to that of the *sclerotic;* occasionally it was rendered more granular, or finely molecular, as if dusted, and in some cases fat-molecules were seen in it. In many instances these changes were permanent, constituting various kinds of opacity, *leucoma*, &c.; but in others, they were succeeded by a true softening of the corneal substance, a *keratomalacia,* and by subsequent, superficial ulceration. Virchow explains these changes by an increased quantity of material,—of exosmotic fluid—received into the elements of the tissue, the corneal corpuscles, and *matrix.* "But," says he, "in these cases there is no exudation in the sense of the term understood in the schools, either free on the surface, which on the contrary becomes drier, duller, and more clouded, or interstitial, since there is no evidence of the existence of interstices." With respect to this, in the first place, it is by no means clear, why Virchow will not allow that this increased exosmosis of fluid, which, nevertheless, is manifestly the cause of the swelling of the *cornea,* is an exudation in the sense of the schools, since exudation and increased exosmosis have been regarded as perfectly analogous processes. And, secondly, he denies the existence of an interstitial exudation, though admitting the swelling of the corneal substance, and of its corpuscles.

In order to satisfy ourselves that a molecular material is deposited in considerable quantity between the layers, sepa-

rating them from each other, and thus causing the swelling of the *cornea*, it is simply requisite to dry portions of the tissue thus swollen, and to subject thin sections carried through all the layers of the membrane, and moistened, some with water and others with dilute acetic acid, to observation.

In proceeding to inquire into the mode in which the accumulation of exuded fluid takes place, we must bear in mind the normal conditions of nutrition in the *cornea*. By the injection of various fluids, Bowman has shown the existence in its substance of a complete system of fine canals, disposed in successive planes, and which, in the same plane, are contiguous, and usually parallel though decussating with those of the neighbouring planes. These spaces formed by the fibres of the *cornea*, are analogous to the areolar passages of connective tissue, and, without doubt, in the *cornea*, serve for the conduction of the nutritive material transuded from the capillaries at the margin. In exudative processes in the *cornea*, they would consequently conduce to the more ready diffusion of the fluid product; otherwise it would be impossible to explain how it is that a plastic fluid makes its appearance at the edges of incised wounds through the centre of the *cornea*, from which embryonic forms of cellular tissue are produced.

Exudations, proceeding from the *iris*, and more especially from its anterior portions, deposit their products on the front of the membrane, more or less filling the anterior chamber. The coagulable exudations assume a pseudo-membranous aspect, are sometimes of a gelatinous, sometimes of a more viscid consistence, yellowish, frequently speckled with bloody points, and readily divisible into laminæ; they usually become organized into cellular tissue, which adheres to the posterior surface of the *cornea*, in consequence of which, irregularities of the pupil are produced. It is obvious also that the free movements of the *iris* will be impeded by these adhesions, and that the dilatation and contraction of the pupil will be either imperfectly performed or wholly prevented. A second, frequent metamorphosis of the exudation in question, consists in the formation of *pus*. This exudation is confined, usually, only to the *iris*; the *lens*, vitreous humour, *retina* and *choroid* present no anomaly of the kind.

In proportion as the exudations accumulate on the anterior

surface of the *iris* the same process takes place on the posterior, and in cases of *synechia posterior*, delicate filaments of connective tissue may be traced passing to the capsule of the crystalline lens, in which filaments blood-vessels also may occasionally exist.

In recent times more attention has been paid to *choroiditis*, and in particular has "glaucoma" been referred to this affection. We will here adduce an instance of this form of inflammation, occurring in the cataractous eye of an old man. Towards the inner surface of the *choroid*, after removal of the coloured epithelium, a large quantity of clear elements (fig. 62, *a*) of elliptical or oval form, and without any investing membrane or *nucleus*, came into view. They were about 0·013—0·022‴ in diameter and rested upon a hyaline, firm blastema, which could be easily peeled off, and in which were lodged numerous fat-globules. These elements were crowded into larger or smaller groups, and when the light was too strong might readily be overlooked. Besides these, however, larger corpuscles were soon remarked, presenting, as a common character, a strongly defined border.

FIG. 62.

Three of these bodies are shown at *b*, in one of which the border was indicated simply by a dark shading, whilst in the other two, scattered molecules were visible at the margin. The central portion consisted, in parts, of a structureless, hyaline substance, and groups of fat-globules could be perceived in the interior. The diameter of these bodies (*b*) reached 0·031—0·039‴. They were usually isolated, rarely disposed in a few successive layers, and occasionally, also, were without the distinctly defined border. The hyaline, included substance, as at *c*, was in some, though few, of the bodies, replaced by a reddish-coloured molecular material. Although most of these bodies presented a rounded or oval shape, some occurred of an hour-glass form, as at *f*. Nor was the peripheral border always of equal width, sometimes, as at *g*, having fat-globules imbedded in it. Isolated, granular corpuscles (*d*) of very various sizes were

scattered about. These various kinds of corpuscles were not to be found on the posterior portion of the *choroid,* nor on the ciliary processes. They could be isolated by the needle, and were unaffected by acetic acid, whilst in carbonate of soda their outlines were gradually rendered indistinct.

Now what was the nature of these corpuscles? Are they to be regarded as abortive or imperfectly developed cells, or may they be supposed to arise from a differentiation of the heterogeneous elements of a *blastema?* The complete absence of the *nucleus* and of a cell membrane, is opposed to their being of the nature of cells, whilst on the other hand we see precisely analogous corpuscles on the walls of the follicles of the thyroid gland, already described as being secerned colloid masses, and in which the peripheral solidified substance constitutes a border of greater or less thickness.

CHAPTER V.

5. FAMILY—NEW-FORMATIONS (NEOPHYTES).

An exuded fluid becomes *organized* when elementary organs are produced in it, which either in their character or in the mode in which they are grouped differ from those of the tissue in which the exudation has taken place. The aggregate of elementary organs arising in the exudation is termed a "new-formation." The development of these formations subsequently, under the vital influence and other favorable circumstances, proceeds in the same way as in the normal tissues, that is to say, their elementary organs, like those of the latter, multiply by division. In *comparing* the formative process in these new growths with that which occurs in *hypertrophies*, we shall perceive an essential difference between the two; consisting in this, that in the former, the process is preceded by the formation of a transuded plasma owing to disturbances of the circulation, from which plasma, as originally in that of the *ovum*, new elementary parts arise, whilst in hypertrophy this is not the case. In this condition there is merely an exaltation of the cell-life proper to the organ, owing to which a more rapid multiplication by division takes place; or, in other words, the propagative force of the original cell is, under these circumstances, augmented. But, nevertheless, in nature, the limits are not so sharply defined, and we have frequent opportunities of seeing *hypertrophies* conjoined with *new-formations*.

In a general survey of the characters of new-formations, we cannot ascribe *special characters to any growth of the kind, as regards its elementary organs*, so as to be able, from any given cell, to determine to what kind of new-formation it may belong. There is no such thing as a pathological, new-formed cell, which can be regarded as foreign to the organism; for even when in external aspect it may appear so, it would be equally erroneous to assign it a character, *sui generis*, as it would be in the case of monsters. In these cases the hypothesis of a special for-

mative *nisus* has in former times been raised, such productions having being supposed to arise from some monstrous formative impulse, as, for instance, that of a Cat, Dog, Pig, or Frog; whilst in later times precise anatomical research has established the fact that these monsters are produced simply by circumstances interfering with the course of development. The malformation of many pathological, new-formed cells, their persistence at a definite stage of development, their occasional retrograde metamorphosis, their coalescence into groups, their excessive cell-life, on the other hand, present so many analogies with the malformations of the *fœtus*. In this case we see a malformation, due to an impeded development of one part or another, dependent, it must be confessed, upon circumstances still obscure; these parts become incapable of assimilating, organically, the nutritive material supplied to them, yielding it, as it were, to other parts of the self-developing organism, which, by this superfluity of nutriment, become over developed.

Consequently, we cannot assign to *cancer*, for instance, any more than to tubercle or pus, &c., any special elementary constituents peculiar to it alone; and in this sense, cannot speak of cancer-cells, tubercle- and pus-corpuscles. But in employing this expression we should not connect with it the idea that it signifies organic elementary parts peculiar to cancer, tubercle, and pus only, using it simply in the sense of expressing the fact that in cancer, tubercle, and pus, such and such elements are chiefly present.

We are therefore never in a condition to make the pathologico-histological diagnosis of a new-formation from a few elementary organs presented to our observation, but must, to do this, consider the newly-formed tissue *in toto*. Just as the pathologist establishes the diagnosis of a disease from the entire aggregate of symptoms, so must the pathological histologist found his diagnosis upon the particulars of the newly formed tissue viewed in their totality.

After the various parts of the texture appreciable by the naked eye have been subjected to a close, comparative elementary analysis, it remains to investigate the *intercellular substance*. This may be, either *a thin fluid, a viscous fluid*, or *solid*.

The two former conditions of the inter-cellular substance

exhibit no more appearance of structure than do the serum of the blood, or the contents of the *areolæ* of the vitreous humour. Consequently, in this sort of new-formations, the organic elementary parts are dispersed in a structureless fluid material. When the latter is organizable, interstitial tissues are developed from it either *secondary*, around pre-existing elementary organs, or *primary*, with subsequent formations of the latter, which interstitial tissues, with the cells contained in them, undergo very various organic metamorphoses, and in this way complicate the structure of the new-formation.

Viewing them in this way, the new-formations (neophytes) may be placed in two great divisions: 1. The *simple*, with a structureless intercellular substance, which, in certain cases, coagulates, and gives the new-growth a greater or less degree of consistence. The elementary organs, also, in them, as simple new-formations, do not advance beyond a certain degree of organization. To this class belong, for instance, *pus*, tubercle, vitreous or gelatiniform *mucus* on mucous membranes, &c. 2. The *compound*, with an organized, interstitial tissue, and a manifold capability of development in the organic constituents, as for instance, *sarcoma*, *cancer*, &c. The simple, as well as the compound new-formations, are subdivided, partly according to their general habit, partly from their predominant morphological constituents, into a series of groups, each of which we shall denominate a *family-category* (ideal forms). Each of these, lastly, particularly among the compound new-formations, consists of special forms, whose diversity of structure depends upon the character and degree of the organization of which they are capable.

We do not subdivide the new-formations according to definite principles, either anatomical or chemical, deeming such a division, at once, as impracticable. If we were, for instance, to adopt the term "colloid tumours," as a generic name, we should, by so doing, throw together a multitude of entirely different structures, and produce endless confusion, when it is sufficient simply to say that various kinds of tumours may contain colloid matter. And if we sought to classify new-formations simply from their anatomical structure, we should obtain only a dead, formal division, and, moreover, allied structures would, in this way, be separated. We would here simply indicate

the various forms of *cancer*, to show the nullity of any merely morphological principle of classification. There is no need to hamper ourselves with artificial trammels where our information is limited, and lest in the end we should incur the risk of rendering ourselves incapable of unprejudiced observation.

Let us inquire, then, what does suffice for the character of a "family category" of new-formations? According to what has been observed, it is at once apparent, that neither its bare morphological, nor its chemical elementary constituents, by themselves alone, afford sufficient diagnostic characters. For this it is indispensably requisite to investigate the organic life of the new-growth, and its relations to the entire organism. In the next place, we should endeavour to ascertain its *developmental history*, the mode and kind of its *retrogression*, in order to elucidate the relations in which it stands towards its parent seat.

Steadily retaining the objective point of view, we shall investigate the categories of new-formations in succession, commencing with the *simple* and proceeding to the *compound*, and at the end, subjoin some general conclusions.

I. GRANULE-CELLS, GRANULAR CORPUSCLES, GRANULAR MASSES.

The above terms, together with that of "fatty aggregation-globules," have up to the present time frequently been employed as synonymous. We think they should be subordinated to corresponding ideas, and shall accordingly distinguish three categories of these pathological elements.

1. In speaking of the fatty degeneration of the cell-contents, we stated that they are converted into an agglomerate of fatty molecules, so that ultimately the *nucleus* is rendered wholly invisible. Consequently, in place of the transparent cell, with fine-molecular contents and a *nucleus*, we have, simply, an aggregation of fatty molecules still surrounded by the cell membrane; the fine-molecular cell becomes a *granule-cell*, which, according to the original figure of the cell, may be conical, fusiform, rounded, &c. The cell-membrane disappears, nothing remaining but the liberated heap of fatty molecules, which, owing to the prominence of some, at the periphery, exhibits a fine, indented border. This fatty degeneration, as we have pointed out in

the General Part, takes place not only in the original, pre-existing normal cells, but also in those of new, pathological formation, and corresponds to the involution of the old or new cells. As good subjects for study in this regard, the epithelial cells of the *tubuli uriniferi* in Bright's disease, or those on the inner wall of the cysts of the thyroid gland, may be recommended.

B. Reinhardt first propounded the law that all nucleated cells with albuminous contents, whether occurring in the normal condition in the various organs, or newly formed in the course of pathological processes, may, under particular circumstances, become granule-cells; and in a subsequent work upon the genesis of granule-cells in general, he has stated that the granule-cells (regarded as aggregations of fatty molecules) are developed from nucleated cells, fatty molecules being deposited in their contents. We conceive that the second proposition, with respect to the genesis of granule-cells from nucleated cells, is expressed too generally, as will appear in the following categories.

2. There are found, both in the brain and in the spinal cord, in parts that are the seat of inflammation, usually of some standing, and which are in the condition known as "red or dirty-grey softening," vast numbers of the pathological new-formations, described more particularly by Gluge, and denominated by him "compound inflammation-globules." These are corpuscles sometimes round or oval, sometimes of an elongated form (fig. 63, the dark corpuscles among the primitive nerve tubes), in which shape the longitudinal diameter may even be half as much again as the transverse. In size they vary from 0·004—0·013‴; and in rarer instances, may even exceed these dimensions. They are composed of granules, measuring 0·00088—0·0013‴, and which when isolated present the aspect of dark-bordered globules, with a clear centre, like minute fat-globules. The

Fig. 63.

superposition of these globules, so that they constitute one body, gives the latter a dark, brownish-yellow colour. In many, a round, lighter spot may be perceived, corresponding to a vesicular *nucleus*, which occasionally projects on the border, so far, as to be nearly half exposed. Those represented in the figure, were taken from the lumbar portion of the spinal cord of a paraplegic individual, and were lodged, as isolated corpuscles, among the primitive nerve-tubes. Besides these corpuscles, some elementary granules are also apparent, which, in many instances, increase in size, so as to become fat-globules, which float in considerable quantity on the surface of the water with which the preparation is moistened; at the same time the nerve-tubes are gradually destroyed, and thin sections of the parenchyma will be found to have lost their proper, normal transparency.

According to Vogel, these corpuscles are not changed by water; but they are disintegrated by the prolonged action of acetic acid and of ammonia, breaking up into the separate granules of which they seem to be composed (an effect which, according to our own observations, also ensues upon the more prolonged action of water). The constituent granules are, occasionally, but not always, dissolved by caustic potass and by ether. The granules appear to him, from their chemical reactions, to be constituted sometimes of fat, when they are soluble in ether, sometimes of a modification of *protein*, sometimes of earthy salts.

The question now arises: whether these corpuscles are also produced from cells, like those described in the first category, and whether these supposed cells, in a state of fatty degeneration, should be regarded as original and normal, or of new-formation and pathological? The circumstance that their mean size does not correspond with that of any degenerated ganglion-cells, and that they have been observed in the columns of the spinal cord, and even in the course of the optic nerve, allows only of our regarding them as of new-formation. Though fully acknowledging the correctness of Vogel's observations with respect to the formation of his granule-cells in pneumonia, which he shows to arise from a nucleated cell, whose wall disappears, still we are unable to satisfy ourselves of the universal applicability of this theory of their formation. In the corpuscles in question, from the central nervous system,

we have never observed a cell-membrane, and are, consequently, without any grounds for believing that such a membrane has existed and been removed. We consider, therefore, that the term granule-cell is inappropriate to these corpuscles, since one attribute of a cell, viz., the wall, is wanting in them; and think that the designation of *granular corpuscles*, previously proposed for them by Bühlmann, is more suitable. Their mode of formation may consist in the preformation of a *nucleus*, around which the fatty molecules, united by a connecting substance, are deposited; the formation of a cell-membrane is not reached, and the cell-formation ceasing with that of the *nucleus* and contents, is, consequently, incomplete.

3. The fatty molecules suspended in a plastic fluid, appear to be furnished with a viscous, albuminous covering, by which, probably, they acquire the property of becoming agglutinated. They collect into groups, and this gradual aggregation may be observed, especially in the somewhat larger fat-globules of about 0·002—0·003‴, a few of which appear to unite into a small group, which obviously contains no nuclear body. They represent, therefore, simply an agglomeration of fat-globules, and the expression of "granule-masses," selected by C. Bruch, instead of the usual one of "granule-cells," is appropriate to them. But it seems to us, that that observer has propounded an untenable theory, when he states that the *nucleus* is not formed until subsequently, in the conglomerate body. Virchow employs the term, *fat-aggregate-globules.*

From the comparison of these three categories, it appears: 1. That the granule-cells represent a fatty degeneration of original or of new-formed cells; the granular corpuscles a deposition of fatty molecules around a pre-existing *nucleus;* and the granule-masses a simple collection of fat-globules. 2. That the granule-cells, after the dissolution of their cell-wall, are no longer distinguishable from the granular corpuscles, and that the latter, when their *nucleus* ceases to be apparent, are identical with the granule-masses.[1]

[1] [In speaking of the atrophies of tissues, we were obliged to institute two series, which morphologically are often quite indistinguishable, though essentially so genetically; one of these series of atrophies arises in a diminished, the other in an increased transudation. The effect of these processes consists in an involution of the original tissue; this is shown not only in a morphological transformation of the

We may now proceed to a general exposition of the occurrence of the three categories in the various tissues.

In stagnant *blood*, both within the vessels, as in larger aneurismal sacs, as well as externally to them in cases of extravasation, where the blood has been poured out into the parenchyma of the organ in consequence of the rupture of a vessel, dark-grey granule-masses arise, composed of aggregated fat-globules; these masses lie scattered among the necrosed blood-corpuscles, and not unfrequently assume a dirty-yellow or yellowish-red colour, from their being imbued with hematin. Their size varies a good deal, and is, not unfrequently, four times that of the white blood-corpuscles, so that they cannot by any means be viewed as a degenerated form of the latter. Fat appears to be formed in considerable quantity by the decomposition of protein-compounds, which, in a state of minute division, forms the bodies in question by the aggregation of its minute particles. Newly-formed *nuclei* also, under these circumstances, serve as points of collection for the fat-globules.

After suppuration in the interstitial *connective tissue* of the muscles, colossal granule-masses are, not unfrequently, left; in the same way they are deposited on the cellular sheaths of the smaller *vessels*, as may be observed, especially in encephalitic inflammations, where the presence of these corpuscles may be observed even on the minutest capillaries. In fig. 64, are represented blood-vessels of various calibre from an inflammatory *focus* of old date in the *corpus striatum*. On their outer wall, granule-masses are visible, which in parts surround the vessel like a border, constituting continuous chains. Their size ex-

FIG. 64.

cell-contents, &c., but also of the intercellular substance in which an accumulation of fat in a state of minute division in separate groups often occurs, to which the name of granule-masses has been applied.

ceeds the diameter of the capillaries. Besides these, the outer wall is also covered by isolated granules (elementary granules), which, as we observed in speaking of atrophies, should not be confounded with the fatty forms of involution of the constituent elementary organs of the capillaries, minuter arteries, and veins (*vid.* fig. 24). These adherent granule-masses may arise from a transuded plasma adherent to the outer wall of the vessels, or, according to L. Türck, may be regarded as deposited upon the vessels.

When the deposition of these granule-masses takes place in considerable quantity, and over a considerable space, vessels so affected, if of a certain size, are evident even to the naked eye as greyish-white streaks, and may be readily dissected out, as has already been remarked by L. Türck.

In the *larger vessels*, up to the *aorta*, the granule-masses may be noticed not only in the cellular coat, but even in the middle and internal coats, consisting in these situations, sometimes of globules, disposed in longitudinal series, sometimes of variously shaped, irregular agglomerations of globules, which occupy considerable interspaces between the reticulated fibrous layers.

The appearance of granule-masses on the *mucous membranes* is very common in catarrhal affections, and it is yet uncertain whether, in this situation, they arise directly from mucus- or pus-corpuscles in a state of fatty degeneration. The former are met with especially in the whitish, mucous masses, on both the respiratory and digestive mucous membranes, and of the most various dimensions.

The metamorphosis of the epithelium of the pulmonary air-cells into granule-cells, has been observed by B. Reinhardt in the most various pathological conditions of the lungs. He noticed this metamorphosis, several times, in portions of lung which had been compressed by pleuritic effusions, but which themselves contained no exudation in their tissue; and, on one occasion, he noticed the same thing, very distinctly, in a case of extensive atelectasy of the pulmonary tissue in a person dead of typhus fever. Very frequently, also, in the first stage of pneumonia, he has found the *epithelium* filled with fatty molecules, whilst in red hepatization the epithelial cells, transformed into granule-cells, had disappeared. With respect to this, it

should be remarked, that Reinhardt, under the term "granule-cells," comprehends only an agglomeration of fatty molecules, regarding them consequently as equivalent to the granule-masses. From his observations, he concludes that all the granule-masses met with in the lungs are nothing more than altered epithelial cells, and is no longer disposed to consider them as a new-formation in the exudation. We do not regard this proposition as of universal application, since in other situations precisely similar bodies occur where there can be no question of a fatty metamorphosis of the normal elementary organs, as for instance in the brain, spinal cord, nerves, &c.

A perfectly analogous condition occurs in the *kidney*. In this gland the fatty degeneration of the epithelial cells is a well-known condition in *morbus Brightii*; although here also we do not think that the *genesis* of the granule-masses from degenerated epithelial cells, can be considered as a universally established fact. B. Reinhardt has sought to explain the considerable size of the granule-masses, and their spherical figure, by the assumption that the flattened, polyhedral cells of the *tubuli uriniferi*, enlarge and acquire a globular shape from the deposition of fatty molecules in their contents.

In a case of puerperal *endometritis*, we found, on the inner surface of the *uterus*, at a point corresponding to the insertion of the *placenta*, a great number of granule-masses of very various sizes, of a globular form, some of which were three times as large as pus-corpuscles; the latter, therefore, must undergo a considerable increase of volume unless an independent agglutination of the fat-granules around them be assumed to take place.

In the milky, turbid fluid of the enlarged prostate, a great quantity of granule-masses may frequently be noticed; these corpuscles together with the epithelial cells in a state of fatty degeneration are, without doubt, the cause of the milkiness of the fluid; throughout which they are not uniformly distributed.

The *newly formed elementary organs* very frequently degenerate, as has already been stated in the General Part, and in consequence of the fatty metamorphosis of the cell-contents become granule-cells, granular corpuscles, or granule-masses. The latter are seen, for instance, in the juice of cancer, in portions of can-

cerous tissue in a state of involution, and in our opinion, afford no reason for the assumption of the invariable pre-existence of a cell, as is apparent from the agglutinated large fat-globules, a few of which, as before stated, appear to unite into a small group, and to enclose no nuclear body. The example cited above may suffice, since, besides that, we shall have frequent occasion, in speaking of new formations, to return to the subject.

The *pathological import* of the granule-masses, was appreciated by their discoverer, Gluge, when he stated that they were a product of the inflammation; he termed them, therefore "compound inflammation-globules," a designation which may be regarded as so far incorrect, since these bodies have been found in a normal secretion, viz., in the *colostrum*, by Donné, and may also be developed from the fatty metamorphosis of the cell-contents in genuine atrophy of an organ. B. Reinhardt regards the transformation of nucleated cells into non-nucleated corpuscles, which takes place under these circumstances, as indicative of a retrograde process in the cells, dependent, as he expresses it, not upon a metamorphosis arising from the vital development of the cell, but rather upon changes to which the cell is subjected so soon as its vital activity begins to flag. But he overlooked the formation of granule-masses in the intercellular substance, before noticed by Rokitansky, which bodies, without any previous cell-formation are of the nature of fatty aggregations.

That the granule-masses, even when accumulated in very large quantity, have, in many cases, nothing to do with an exudative process, is evident, especially from the very extensive researches of L. Türck, with respect to the secondary affections of the separate columns of the spinal cord, and their continuations into the *cerebrum;* and with regard to the effects of compression upon the optic nerve. This author has shown, that the formation of granule-masses, in parts so strictly defined as the above, takes place simply as a consequence of the paralysis (atrophy): for if the existence of any exudation-process were assumed, such a limitation of the formation of granule-masses to the individual medullary columns, even were the presence of certain dissepiments between the latter (which are not at present demonstrable) admitted, would not be con-

ceivable. In such cases, therefore, we can only regard the granule-masses as products of the decomposition of the normal fluid of the tissue.

II. PUS.

There is but one *true, genuine pus;* and the terms of "improper" or "false," pus, may be dispensed with as being wholly unscientific.

In the *pus,* termed by practitioners *bonum et laudabile,* we find, as the predominant, organic morphological element, spherical corpuscles, which cannot be accurately distinguished as such under a less magnifying power than one of 300 diam. These bodies have received the name of *pus-corpuscles.* They are constituted of a soft, granular substance, and are of a greyish hue. In size they usually measure 0·0044‴, but may be greater or less. It is as yet undetermined whether these diversities of size are connected with the individual by whom the pus is afforded, or with the nature of the disease, as J. Vogel supposes; who has remarked that the size of the pus-corpuscles of an abscess and of a wound is tolerably constant—in the one case they are all small, and in the other all large.

Their spherical figure is satisfactorily seen when the pus is diluted with water or a weak solution of salt or sugar, and the corpuscles are made to roll about, under which circumstances they are invariably seen to retain the round form. Their globular shape may also be deduced from the conical shadow thrown by them when illuminated by oblique light. Many pus-corpuscles, particularly the larger forms, exhibit a cell-membrane, though, in most cases, they appear to be bounded, simply by a delicate granular material.

When pus is left at rest in a deep glass vessel, the corpuscles subside to the bottom, constituting the greater part of the "pus-crassamentum." Under these circumstances, they cohere and form a granular, easily crushed mass.

In order to understand their structure, it is requisite to observe them in various *media.* Of these, dilute *acetic acid,* is especially recommended by J. Vogel, in which they are rendered pale, and in their interior may be observed one or several corpuscles, which are regarded as *nuclei.* The size of the latter varies from 0·00088—0·0026‴. They are largest

when solitary. The multiple *nuclei* are always united into a single group; and as many as five have been counted in a pus-corpuscle. When two *nuclei* occur together, they present a biscuit-shaped or hour-glass form, three assuming that of a trefoil leaf. Henle and J. Vogel have occasionally observed *nuclei* of an elliptic form, and at the same time hollowed on each side like a blood-corpuscle, occasionally, spherically distended or ovoid.

This effect of dilute acetic acid upon the pus-corpuscles and, in particular, the manifestation of the multiple *nucleus*, is so characteristic, that we have in that reagent a ready means of distinguishing pus-corpuscles from other elementary bodies—as, for instance, from young connective-tissue-cells.

When pus-corpuscles are acted upon by water, they visibly enlarge, becoming, at the same time, more transparent, and, in many, the simple or divided *nucleus* is distinctly apparent; consequently, it cannot be assumed that the acetic acid produces an artificial subdivision of a simple *nucleus*. Occasionally, also, when the pus-corpuscle is thus enlarged, if it be furnished with a cell-membrane, the rupture of the latter, and the escape of the *nucleus* and of the molecular substance, may be observed.

If *concentrated saline solutions*—as, for instance, of common salt—be applied to pus-corpuscles, they lose part of their watery contents, shrinking visibly, and again swelling up on the addition of water.

J. Vogel has instituted extensive researches with respect to the influence of various substances upon pus, with the following results. Moderately dilute solutions of most neutral salts—such as muriate of ammonia, common salt, nitre, &c.—when their action is prolonged, dissolve the investing substance and, except the *nucleus*, the contents also, in great part, of the pus-corpuscles, and causing even the *nuclei* themselves to swell, so as to lose their sharp outlines and to become fused into an ill-defined mass. The alkaline carbonates, a solution of borax, and, still more rapidly, caustic alkalies, convert the pus-corpuscles into a mucoid matter. The envelopes, as well as the *nuclei*, disappear, nothing remaining but extremely minute, dark molecules, probably of a fatty nature. Substances which coagulate fluid albumen—such as metallic salts, tincture of

iodine, alcohol, &c.—render the pus-corpuscles cloudy and opaque. Saliva, *mucus*, urine, blood, and the other fluids of the body do not usually exert any important effect upon the pus-corpuscles; the bile only, disintegrates them. Boiled with concentrated hydrochloric acid, the corpuscles behave as do protein-compounds; they colour the fluid violet.

When the above properties of the pus-corpuscles are compared with the elements known as white blood-, salivary, and synovia-corpuscles, no important distinctions are found to exist between them, or, at most, only such trifling differences as are insufficient for the establishment of any certain diagnosis. Acetic acid acts upon the last-named corpuscles exactly as it does upon those of pus; and, consequently, the various dimensions of the latter, and the occasional existence of a cell-membrane, alone remain as indicative of any points of difference.

1. The *white blood-corpuscles*, in Man, never exceed in size the volume of the small pus-corpuscles—0·0035‴.

2. The *saliva-* and *synovia-corpuscles* exceed the latter dimensions, the former also presenting a comparatively large *nucleus*, which less frequently subdivides into multiple *nuclei*.

The *serum of pus*, its fluid constituent, analogous to the blood-*serum*, presents no morphological elements beyond solitary suspended granules and floating fat-globules. The salts held in solution in it crystallize in dendritic forms upon the spontaneous evaporation of the fluid.

Besides these usual constituents, fibrinous (filamentous networks soluble in acetic acid), flocculent or granular masses are met with in the more consistent kinds of pus.

FIG. 65.

Several kinds of *pus* contain *mucin*, which, upon the addition of acetic acid, is thrown down as an opaque substance, and when examined under the microscope, is seen to be composed of very delicate, straight filaments (fig. 66); and it appears to be deposited in several successive layers. According to Lehmann, these *mucin*-filaments are dissolved by concentrated acetic acid, especially when warm. This substance is identical with that termed by Güterbock *pyin*—a name which cannot

be admitted, since, as shown by J. Vogel, *pyin* rarely occurs in normal, and frequently exists in abnormal pus, as well as in other pathological products, as, for instance, in *carcinoma*.

Other *solid particles* are frequently *mingled* with pus, such as red blood-corpuscles, derived from the rupture of the smaller vessels in the walls of the abscess, minute plates of *cholesterin*, and accidentally detached epithelial cells. Crystals of triple phosphate of magnesia and ammonia, *vibrio monas* and *v. lineola*, are seen only in putrefying pus. The *pus-corpuscles* are subject to a *fatty metamorphosis* of their contents, manifested by the appearance within them of strongly defined, brilliant molecules which are not removed by the action of dilute acetic acid or of a solution of carbonate of soda or potass. An instance of incipient fatty degeneration of *pus* is shown in fig. 65, representing pus taken from a diffused subcutaneous abscess. In the isolated or grouped, granular pus-corpuscles, dark points will be perceived, which, when the *focus* was well adjusted and a sufficient magnifying power employed, exhibited a clear centre. At the same time, also, sharply defined, larger and smaller fat-globules were seen, occurring free, on the surface of the preparation, and which were consequently brought into view when the focus was elevated. This free fat increases as the degeneration of the corpuscles advances. In fig. 65 are also shown various admixtures, such as red blood-corpuscles, in the wrinkled and non-wrinkled condition, two *epidermis*-cells with their oval *nuclei* and a coagulated protein-substance in a tubular form, covered with a molecular material.

In proportion as the fatty degeneration advances, the characters of the pus-corpuscles are lost, nothing remaining but scattered molecules; the periphery of the corpuscle becomes indistinct, and upon the addition of acetic acid the *nucleus* can no longer be plainly perceived. At the same time, also, the amount of *olein* in the pus-serum is augmented, and not unfrequently, in *pus* in this condition, after the action of acetic acid, the filaments described under the name of *mucin*, are met with. It is plain, that in *pus*, thus liquefied, the histological diagnosis is impossible, inasmuch as the morphological constituents—the pus-corpuscles—are wanting. Virchow was the first to show that a similar degeneration takes place in the colourless blood-corpuscles (isomorphous with pus-cor-

puscles), and that, in proportion as they become filled with fat, they increase in size, and assume all the forms of the so-termed granule-cells or inflammation-globules. Reinhardt has observed a similar process in the case of the pus-corpuscles.

But the rudimentary pus-corpuscles may also wholly disappear as is the case in what is termed *sanies*. In this case the formation of corpuscles is either altogether wanting or is extremely imperfect. The fluid presents merely molecular particles, dirty, brownish-yellow *flocculi*, a great abundance of fat-globules, and, occasionally, detached fragments of connective and elastic tissues imbedded in a brownish-yellow, molecular matter. Crystals of phosphate of magnesia and ammonia and *vibriones* very speedily make their appearance. It must, perhaps, be assumed that as the formation of *sanies* advances, no development whatever of pus-corpuscles is ever attained to.

Many kinds of *pus* contain a large proportion of water, and are consequently thin and fluid. The pus-corpuscles of this *serous pus* are rarefied and swollen.

Pus appears to be developed from a, principally, albuminous exudation, which, as was first remarked by Rokitansky, is in many cases combined with one of a *fibrinous nature*. In the latter case the amount of pus-corpuscles is less, and these, enclosed in coagulated fibrinous masses, form, according to Rokitansky, the so-termed *pus-clots*, or *plugs*. He thinks that the pus-cell is developed, not from the solid fibrinous exudation, but from the sero-albuminous fluid associated with it. In these kinds of pus, containing a large amount of *fibrin*, young connective-tissue-formations also, are constantly met with, which appear to be produced from the fluid fibrin.

The *formation of the pus-corpuscles* is described by J. Vogel, from his own observations made on recent wounds cleansed from blood, to take place in the following mode. There first appear in the fluid secretion of the wound, minute granules, less than $\frac{1}{1000}'''$ in size, corresponding chemically with the molecules of pus, and insoluble in alkalies and in borax. Subsequently, somewhat larger corpuscles, $\frac{1}{500}$—$\frac{1}{800}'''$ in size, make their appearance, partly around these molecules, partly independently of them. These bodies, which are soluble in alkalies, and insoluble in acetic acid, correspond with the *nuclei* of the pus-corpuscles. The *nuclei* are sometimes solitary, sometimes

in groups of two or three together, when they assume a trefoil figure, and thus constitute the *compound nuclei*. Around them is afterwards developed the cell-wall, at first as a mere transparent membrane, which is subsequently thickened, and becomes granular, and thus is produced the *pus-corpuscle*. This formation of pus-corpuscles takes place with considerable rapidity; he often noticed perfect corpuscles within three or four hours of the first appearance of the *nuclei*; in other cases it proceeded more slowly. Occasionally, he observed a simple, apparently vesicular *nucleus*, excentric in a transparent, elliptical cell-wall, with a sharp external contour. Cell-nucleus, contents, and wall, subsequently undergo, simultaneously, farther metamorphoses. In other instances, the nuclear body alone existed, surrounded by an undetermined granulo-amorphous deposit, without any sharp outline, and, as the endosmotic conditions showed, without any closed cell-wall. This latter condition of the pus-corpuscles is without doubt the most frequent; the majority of them, therefore, do not merit the name of cells, but are for the most part to be regarded as imperfect cell-formations. That pus-corpuscles without cell-walls, as well as complete cells, may *multiply by division*, and that every corpuscle does not arise primarily from the *plasma*, is more than probable. This notion is, we think, supported especially by the diversity of form exhibited by the *nuclei*, and of size by the pus-corpuscles. The biscuit-shaped *nuclei* have a tendency to divide into two halves, and those of a trefoil shape into three parts. When, in this way, two, three, four, and five *nuclei* have been produced from one, by the process of division, they separate from each other, the contents of the pus-corpuscle subdividing into as many portions. Thus, the property of multiple division possessed by the *nuclei* would indicate a rapid multiplication, as may be observed on a greater scale, and more conveniently, in medullary cancer, and as has been described in our account of the cell-theory in the General Part.

In speaking of pus, other elements should be noticed, which, although not belonging to the *pus* as such, are yet occasionally met with in it. These bodies occur most frequently, and in the greatest abundance, in the pulmonary air-cells and *bronchiæ*, in cases of red hepatization of the lungs, and in the *sputa* in *pneumonia*. They consist of finely-granular globules

0·008—0·022‴ in diameter, with a sharply defined cell-wall. No *nucleus* can, in any way, be detected in them, and they are, consequently, non-nucleated vesicles. They usually present a yellowish or yellowish-brown colour, and not unfrequently, also, contain dark, scattered pigment-molecules. In order to represent them, the *sputa* of a person affected with pneumonia were taken, and treated with dilute acetic acid (fig. 66). The pus-corpuscles are seen with very pale, scarcely distinguishable outlines, and simple or multiple *nuclei*, among the filaments formed by the *mucin*. At the lower part of the figure are seen four, larger, granular globules, which, after treatment with acetic acid, did not undergo the same change as was exhibited by the pus-corpuscles.

Fig. 66.

In the case of these bodies, it may be inquired whether the *nucleus* had previously existed, and had perished in the non-nucleated corpuscles, or whether the formation of a *nucleus* had not been reached, but simply that of a cell-membrane around a portion of contents. We have already stated in the General Part, that the theory of cell-formation affords too scanty means for the determination of this difficult question. It is, perhaps, probable, that there may be such things as sterile cells, which, like *ova* incapable of germination, are not further developed, owing to their imperfect organization, and that these non-nucleated globules not improbably represent cells of this kind. They are essentially different from the *granule-masses*, which consist of more voluminous granules, and have no cell-membrane, whilst the molecules of the sterile cells (?) are of immeasurable minuteness, and enclosed in a cell-membrane. From any kind of epithelial cells, they differ, in the absence of the *nucleus*, the diversity of their size, and their globular form; consequently, there are no grounds for regarding these fine-granular vesicles as any sort of metamorphosed epithelial cells.

These granular globules occur, as has been observed, as new-formed elements, together with pus-corpuscles, especially on

the mucous membrane of the air-passages, of the intestinal canal, and of the *uterus*. They are found in the stools in *diarrhœa*, where, however, the usual, scattered pigment-molecules are wanting in their contents. They present the same appearance, after exudations on serous and fibrous membranes, and in the brain. We have often noticed them, also, among the elementary corpuscles in cancer.

We shall now return to the *pus-corpuscles*, and discuss their *special relations* in various parts of the organism.

A condition of the blood was first accurately described by Virchow, in which a superabundance of white corpuscles exists in both the arterial and venous blood, and to which he assigned the name of *leukhæmia*. In cases of this kind, there are found within the vessels, *coagula*, sometimes gelatiniform, sometimes of a consistence like that of coagulated fibrin, and of a yellowish, greyish or greenish colour. When the liquid portion of the *coagulum* is expressed, it is found to consist of a greyish, greyish-yellow, or yellowish-green fluid, in which chiefly, are contained the elementary organs known under the name of "white blood-corpuscles." These bodies are entangled in a finely-interwoven filamentous network (coagulated fibrin), which constitutes, as it were, the fundamental stroma of the *coagulum*. The red blood-corpuscles are rarefied, and even in the more bulky *coagula*, as, for instance, those in the cardiac cavities, occur only sparingly in the form of blood-red streaks. This preponderance of white blood-corpuscles may be noticed even in the finer ramifications of the vessels.

Whether a partial leucæmic condition is developed in exudative processes, cannot be positively stated, although in many cases such an occurrence may be supposed probable. If fine vascular branches are taken from proper situations around a centre of exudation by means of the scissors, white blood-corpuscles will most probably be exhibited, disposed in rows in the interior of the vessel. But whether these corpuscles are actually of new formation, or have merely arisen from an accumulation of those already existing, in consequence of the blood-*stasis*, we will not venture, for reasons previously stated, positively to decide.

Virchow looks upon *leucæmia* as indicative of an impeded development of the blood, a view which is based upon the

consideration that a genetic connexion exists between the red and white blood-corpuscles, but which, it must be confessed, has not yet been elucidated in all its particulars.

That a transition, from *leucæmia* into *pyæmia,* takes place, or, properly speaking, that merely a distinction of gradation exists between these two conditions, is obvious from the comparative investigation of the *coagula* in the various systems of vessels. In a well-marked case of *leucæmia,* with congestion of the lungs, greatly enlarged liver and spleen, the veins in the *plexus choroideus* of the brain were as completely filled with a purulent fluid as are the veins of the *uterus* in the affection erroneously termed uterine *phlebitis.* The reticulated, fibrinous *coagula* had disappeared, nothing being presented but pus-corpuscles (like the white blood-corpuscles).

A large quantity of pus-corpuscles is developed from the exudations, deposited on the mucous surface in catarrhal affections; in this situation the corpuscles have received the name of *mucus-corpuscles,* although they exhibit no morphological peculiarities whatever. The glutinous, occasionally diffluent, turbid new-formation, usually of a gelatinous consistence, deposited on the mucous membranes, has been designated, "puriform mucus," &c., and is distinguished from what is termed normal pus, by the greater amount of intercellular material containing *mucin.* The cloudiness in the pathological mucous discharges in *coryza,* bronchial catarrh, &c., is due, not only to the pus-corpuscles, but also to the *mucin,* which is precipitated whilst within the organism. For immediately after the discharge of these turbid secretions, mucin-filaments may be discerned, which, after treatment with acetic acid, make their appearance in still greater abundance.

The deep-yellow or yellowish-red colour of the *mucus* usually depends upon the quantity of disintegrated red blood-corpuscles.

The formation of pus-corpuscles from the exudation deposited on the surface of the mucous membrane proceeds with great rapidity. They do not, however, constitute the only organized new-formation; on the contrary, often being wholly or partially absent, embryonic connective-tissue-formations presenting themselves in the clear, gelatiniform mucous matter (gelatiniform *mucus*). But this subject we shall reserve for fuller discussion hereafter.

The exudation poured out on the surface of the mucous membrane is afforded by the close, capillary plexus of the *corium*, and in consequence of the effusion, the *epithelium* necessarily becomes loosened, and is thrown off. The secretion of the mucous glands may induce a modification of the exudation, but cannot be regarded as the main constituent of the latter; nor consequently, can the pus-corpuscles be regarded as produced from the glandular secretion.

The formation of *pus* may take place also in the *submucous tissue*, owing to which, a gradual solution of the superjacent mucous membrane is effected, when its perforation at a minute point ensues. By the extension of a submucous abscess of this kind, the corresponding part of the mucous membrane is detached over a considerable space. We once had an opportunity of examining submucous abscesses of this sort, in great numbers, in the large intestine of a child affected with atrophy. The pus was greenish-yellow, and diffluent, presenting a great amount of broken-up pus-corpuscles with brilliant molecules; and after treatment with dilute acetic acid, was rendered remarkably turbid.

The production of pus-corpuscles occurs most frequently on the nasal and respiratory mucous membrane; in the latter of which situations, owing to local conditions, it is especially of consequence. In the finer bronchial ramifications, and in the air-cells, the rapid multiplication of these new-organisms causes a complete obstruction of the passages and cavities destined for the transmission and reception of air. In this way are produced the *red* and the *grey hepatization* of portions of the lung. The pus-corpuscles in these circumstances are usually of small size, well characterized, and not unfrequently collected into coherent masses. In other cases, the characters of the pus-corpuscles are more or less lost, as they undergo a fatty degeneration. This retrograde metamorphosis may be observed in the softened parts of the lung in a state of grey hepatization, owing to which, when more advanced, the fibrous tissue of the organ becomes readily lacerable and partially dissolved. In what are termed *"metastatic purulent deposits"* in the lungs, a solution of the affected pulmonary substance proceeds with great rapidity, and an abscess is formed, the walls of which are constituted by infiltrated pulmonary cells containing no air.

When the deposit is seated at the surface of the lung, it is seen to be surrounded by a circle of injected vessels.

In the *external integument*, local conditions occur, similar to those which are observed in the mucous membranes. The formation of pus takes place, either on the surface of the *corium* or beneath it. In the former case, it collects under the epidermis, which is raised in a vesicular form, as may be observed in *variola*, *impetigo*, &c. The pustules of smallpox are especially suitable for the observation of the development of the pus-corpuscles in the mode above described by J. Vogel, since, in one and the same individual, when the vesicles on the head are already filled with fully formed pus, the various stages of the formation of that product may be observed in the lower parts of the body.

In the *subcutaneous tissue*, the development of pus, when a mainly fibrinous exudation is poured out, is limited to minute circumscribed spots, whence the intermediate portions of tissue mortify and are thrown off in the form of consistent sloughs. The best example of this form of suppuration is presented in *anthrax*. In a firm, tenacious slough, about 0·78″ in diameter, of a yellowish-green colour above, and slaty-grey beneath, we noticed a considerable quantity of much convoluted elastic

FIG. 67.

filaments (fig. 67, *a a*) and bundles of connective-tissue-fibres (*b*), which were imbedded in a brownish-yellow or brownish-black amorphous material, and could only be seen

in thin layers. In the core from an abscess on the lower jaw, in a scrofulous individual, beneath the dead portions of tissue, torn and empty blood-vessels could be recognized, together with elastic fibres and connective-tissue-bundles. As newly formed elementary organs, not only were pus-corpuscles presented, but also embryonic connective tissue. In a slough from a very extensive abscess on the *trochanter*, together with a molecular and flocculent matter, and agglomerations of pus-corpuscles, we also noticed fibrils of connective tissue and elastic filaments. Thus it is evident, that, just as on the surface of the mucous membranes and of the external integument the *epithelium* and *epidermis* are detached by the layer of exudation and thrown off, so in the subcutaneous tissue, and in more deeply seated suppurations, in other textures, the portions bathed by the pus die and are thrown off.

A similar *necrosis*, or partial solution, takes place in the investing *cartilage* of the joints, in consequence of suppuration in the bone. In these cases, the cartilage-cells, and even the intercellular substance, undergo a fatty degeneration, lose their transparency, and are ultimately wholly unrecognizable. In local, total destruction of the cartilaginous investment, portions assume the appearance of jagged ulcerations, at the periphery of which the above atrophied forms of cartilaginous tissue are seen, whilst on the floor of the ulcer pus-corpuscles are apparent.

The purulent infiltration of the synovial capsule alone does not cause any necrotic changes in the osseous tissue.

With the formation of pus in the joints, *is very frequently associated a partial new-formation of connective tissue*, which, when proceeding from the bone, also produces an ulcerous erosion of the investing cartilage; when it takes place from the synovial capsule, it is to be regarded as an indication of incipient *anchylosis*.

Dubois, not long ago, made the discovery, in newly born infants affected with congenital syphilis, together with a superficial erosion of the liver and kidneys, and with *pemphigus*-vesicles or *erythema* on the skin, of a formation of pus in the *thymus*. Braun and Späth, who have paid attention to this subject, have found in the lobes of the *thymus* thus affected several cavities filled with a purulent fluid, or a single, larger

central cavity, which also enclosed a yellowish turbid fluid. The latter no longer contained, as in the normal condition, the well known nucleated, grey elements, but granular globules, which after treatment with dilute acetic acid exhibited the characteristic *nuclei* of pus-corpuscles. In the intercellular fluid also, the straight filaments of *mucin* were apparent. In the more consistent portions of the walls of the cavities, in a well-marked case of this kind, a new formation of connective tissue had likewise taken place. Dr. Braun ascertained, that the mother had been affected with copious vaginal discharge, which, by her account, had existed for two years.

In the *abscesses of the liver*, which are termed *metastatic*, the pus-corpuscles are usually in a state of partial fatty degeneration, and sometimes so completely disintegrated, that not a single corpuscle can be recognized. This change is probably due to the reaction of the alkaline bile, which gives the pus a deep green or greenish-yellow colour. Of the disintegrated hepatic parenchyma, the rounded *nuclei* of the cells are left in the abscess. Abscesses in the liver with sinuous irregular walls, should not be confounded with collections of puriform *mucus* in saccular dilatations of the biliary ducts, which retain their smooth walls. In the, often numerous, minute *renal abscesses*, also, to which a metastatic origin has been assigned, the pus-corpuscles exhibit a great disposition to become disintegrated, which in this case perhaps cannot be referred to action of the urine, since the pus-corpuscles formed in *catarrhus vesicæ* seem to be well preserved in the urine when passed. The venous ramules around the abscesses are injected. The solution of the parenchyma is evidenced, partly by the advanced fatty degeneration of the *epithelium* of the *tubuli uriniferi*, partly by the liberated, spherical nuclei. When emptied of the pus the wall of the abscess in the cortical substance is found to exhibit a delicately areolated aspect derived from the remaining bundles of connective tissue—the fundamental stroma of the renal parenchyma; in the medullary substance the bundles of connective tissue, following the course of the *tubuli uriniferi*, are disposed in straight lines.

Pus-corpuscles are seen in very great numbers in the *urine*, in *blenorrhœa vesicæ*, causing a considerable turbidity in the secretion. They subside to the bottom of the vessel, constituting

the well-known purulent sediment. The corpuscles are characterised by a remarkable diversity of size, which is partly owing to the swelling consequent upon the imbibition of watery fluid. *Catarrhus vesicæ* is usually accompanied with a rupture of the smaller blood-vessels, whence the urine acquires various tints of red. The blood-corpuscles appear isolated, and are rendered pale by the removal of some of their colouring matter, or acquire a greenish tinge; in more watery urine they also swell by the imbibition of water. Blood-clots subside to the bottom with the pus-corpuscles, and are not visible until the sediment has been carefully spread out. Occasionally a remarkable quantity of *mucin* drawn out into threads may be noticed, the pus-corpuscles at the same time becoming more rare. Urate of ammonia and crystals of triple phosphate are a not infrequent ingredient in urine of this kind. In more acute cases of *catarrhus vesicæ*, a partial mortification of the *mucous membrane* takes place, in consequence of which, fibrils of connective tissue and tolerably thick, convoluted elastic filaments are detached, and are found in the urine. This circumstance always indicates a previous infiltration of the *corium* of the mucous membrane, and of the submucous tissue.

According to its aspect, the pus might be *confounded* with several other products, either normal or pathological. We will here notice only the most important.

We may have to determine, for instance, whether a glutinous secretion issuing in small quantity from the male urethra, is to be referred to *blenorrhœa*, *spermatorrhœa*, or to the prostate gland. The morphological examination will show in the first case, pus-corpuscles, in the second, spermatic filaments, and in the third, a clear fluid with epithelial cells. Even in dried human *semen*, as obtained, for instance, from the orifice of the urethra in a person who has been hanged, the spermatic filaments may still be readily recognized.

The greyish, turbid fluid which may be expressed from old, encephalitic tumours, contains, as we have before more particularly remarked, granule-masses and granular corpuscles with a molecular substance, together with atrophied vessels, nerves, &c.

In the frequently much enlarged, very pale lymphatic glands, presenting a similarity to cancerous infiltrations, a

milky, turbid fluid may be expressed, containing only the well-known nucleiform elements.

Pus-corpuscles are also wanting in softened tubercle, and in the juice of cancer, whose elementary constituents we shall afterwards more particularly describe.

Having thus studied the subject of *pus*, in its various modifications, we shall proceed to some general considerations with respect to its *pathological import*. Pus, as was first taught by J. Vogel, must be regarded as a new-formation developed out of the exudation; it is clear, therefore, that the exudation, as such, cannot, in any way, be termed purulent. That the pus-corpuscles arise primarily out of a plasma, and cannot be viewed as a kind of multiplication of the white blood-corpuscles, is at once evident from the circumstance, that in fibrinous exudations which are wholly enclosed, groups of pus-corpuscles enveloped by coagulated *fibrin* are produced. In *variola*, also, we witness the production of pus-corpuscles from the limpid *plasma* quite independently of the rupture of a vessel, and, consequently, of the escape of the corpuscular elements of the blood.

The opinion above expressed, and for which the reasons have been assigned, that pus-corpuscles multiply by division, is of pathological importance, inasmuch as it shows how necessary it is to eliminate or destroy these corpuscles, in order to prevent the formation of *pus* from *pus*. For this reason we open an abscess, or destroy these newly formed elements with caustic, in *blenorrhœa* of the eye, or *urethra*

As is the case with every new-formation, so also may the formation of *pus* advance up to a certain degree, ceasing under favorable circumstances, if the nutritive fluid requisite for its multiplication be withdrawn. The defunct pus-corpuscles are now rejected from the organism in a natural way, as by the *sputa* in pneumonia undergoing resolution; or the intercellular fluid, and with it the pus-corpuscles also, when they have again become liquefied, may be wholly absorbed, as happens in the case of abscesses which have undergone resorption. The corpuscles of what is termed normal pus, do not, of themselves, appear to exert any solvent power upon the surrounding tissue, which would seem to suffer injury merely from the pressure of the advancing new-formation.

In what is termed unhealthy suppuration, of which there are

many degrees (and amongst them is to be enumerated incipient fatty degeneration), strictly regarded, we cannot speak of a disintegration of the *pus*. For in fact, in these cases, perfect pus-corpuscles are not formed, inasmuch as the exuded material at once undergoes such chemical metamorphoses, that any kind of organic formation takes place only in an imperfect manner. In the highest degree, or that in which the fluid is sanious, all formation, even of imperfect elementary organs, is precluded. These morbid kinds of pus, and particularly the sanious form, exert such a corrosive action upon the contiguous tissues, as to cause their solution with considerable rapidity. Thus, in malignant smallpox, the *papillæ* of the *corium* are partially destroyed, and cicatrization ensues, followed by the well-known depressions. The striped muscles lose their striation, become pale, soft, easily lacerable, or tinged with the imbibed and altered *hematin;* the vessels are ruptured, and the disintegrated blood-corpuscles give up their colouring matter to the abundant, free fat, the coherent globules of which occasionally present an orange- or even a reddish-brown colour.

These kinds of pus, with an incomplete formation of corpuscles, and a preponderance of serum, would appear to be more readily capable of absorption, and it is supposed that by the admission of this liquefied, degenerated pus, a poisoning of the blood may be brought about, which again, would induce the production of metastatic abscesses. That the *pus* is not transferred bodily from a *depôt* to any other organ is clear. A true absorption of the pus, says J. Vogel, can take place only when the corpuscular portion is dissolved and liquefied. It is evident, therefore, that the pus in the vessels cannot have reached them by a true absorption through closed walls. But if we were to suppose that the pus, as such, has been introduced into the interior of the vessel through a rupture in the walls, it is not clear, on the other hand, why pus should be noticed, collected only in so few places in the vessels; there is nothing to contradict the supposition that, in these situations, the pus is formed from the stagnant blood itself, as in aneurismal sacs, in *leucæmia* we find a mass of white blood-corpuscles to be formed; and this notion would accord with the fact that, in what is termed *phlebitis*, the collections of *pus* coincide with a

local stasis of the blood. The term *phlebitis*, however, is improper, since there is no indication whatever of an inflammation of the venous coats.

Mucus, as a pathological product, is to be regarded only as a modified form of pus, which appears, in this instance, to be mixed with a large quantity of *mucin*, and is usually associated with a destruction of the tissue of the mucous membrane. The exudation, however, from which are produced the pus-corpuscles on the surface of the mucous membrane, always infiltrates the parenchyma of the membrane as well, which is thence thickened. Repeated catarrhal affections lead to the atrophy of the mucous glands, and in the affected portions of the membrane the secretion of these glands is rendered more scanty. The unabsorbed exudation also, remaining in the parenchyma, causes the well-known opacities and thickenings. If the suppurative process on the mucous membranes assume a degenerative character, superficial losses of substance ensue, well known as erosions, or shallow ulcers.

III. TUBERCLE.

In proceeding to the histological definition of tubercle, we must, in the first place, inquire whether it is to be regarded as an organized new-formation, or whether the elements occurring in it, are merely the remains of the original elementary structure of the affected tissue?

The histological researches of J. Vogel, Lebert, and several others, have placed it beyond doubt, that an organized new-formation constitutes the basis of the pathological structure which has been designated *tubercle* by the morbid anatomists of modern times.

The *morphological elements* proper to tubercle, as such, and which should not be confounded with those of the tissue in which the tubercular deposit is seated, must first be viewed in serous membranes or in the brain, since, in these situations, the almost unavoidable risk (as for instance, in the investigation of pulmonary tubercle) is not incurred of regarding half-destroyed tissues as new products. It is requisite, also, in order to obtain a general idea of the subject, to institute a comparative analysis of tubercle, under its different conditions,

as regards colour, consistence, and form. The elements are: 1. *Molecules*, some of immeasurable minuteness, which, when assembled in several superimposed layers, assume a brownish-yellow colour, and entirely conceal the other elements. These granules, according to J. Vogel, do not all behave in the same way towards reagents. The greater part of the minute, coloured granules remain unaltered in acids, alkalies, and ether. That author regards them as modified protein-compounds. Together with the delicate molecules, there is visible, especially in the softer or yellowish-coloured tubercle, a considerable quantity of large, strongly refractive globules, which float on the surface of the water, and resembling free fat, are soluble in ether. A third kind of these granules are calcareous salts (phosphate and carbonate of lime), grouped occasionally into amorphous masses, and soluble in acetic acid, sometimes with effervescence. They are met with especially in tubercles in a state of involution.

2. *Flocculent masses*, which are not seen until the substance of the tubercle is carefully spread out; they are coagulated protein-bodies, and exist more especially in the more consistent forms of tubercle. Occasionally, also, concentrically laminated colloid bodies are seen.

3. *Nuclei*, imbedded in a hyaline matrix, with scattered molecules; they are 0·0017—0·0039‴ in diameter, and of a rounded or oval form, and usually contain, in their interior, together with some granules, a distinct *nucleus*. They resist the action of acetic acid.

4. *Flattened, occasionally angular, granular corpuscles*, as much as 0·0052‴ in size, rarely with a distinct *nucleus*; acetic acid renders them transparent. We not unfrequently find bodies perfectly isomorphous with these, in new-formations occurring in *typhus*, and regard them as an abortive form of cell-formation (primitive corpuscles). They have been described by Lebert, as *tubercle-corpuscles*, who even regarded them as of a specific nature. He adduces, especially, the circumstance that the so-termed tubercle-corpuscles, present no *nucleus* when acted upon by acetic acid, whilst such things, for instance, as pus-corpuscles, which might perhaps be confounded with them, exhibit the characteristic, often-described *nuclei*. In what light, moreover, we are to regard the specific nature

of these bodies, appears from what Lebert says, in another place: "tubercle, therefore, in the crude state, contains an element altogether peculiar to it, and by which it is distinguished from all other morbid products," and two pages further on, he says: "in numerous instances, we have ascertained the conjunction of cancerous and tubercular matter in the same morbid product."

5. *Cells with distinct nuclei*, and occasionally of an elongated form, constitute, when they are present, merely the peripheral layer.

From the elementary constitution of tubercle, of which the above general outline has been given, it is obvious:

1. That the organized new-formation is usually limited to the production of *nuclear bodies* and aborted cells.

2. That tubercle contains no positive, characteristic, morphological elements. Its microscopical diagnosis, therefore, must be made *per exclusionem*. If a pathological new-formation consist only of the above-described elements, contain no blood-vessels or -spaces in its interior, and have nowhere a fibrous matrix enclosing the cells, it is a purely tubercular new-formation. But where the above-described elements constitute only a portion of a new-formation—for instance, of a cancerous growth—whilst in another part completely-developed cells, in their various forms of degeneration, blood-vessels, and -spaces, and an areolar matrix-tissue, existed, we could view the structure merely as a cancerous growth, in one portion of which the organization was less complete than elsewhere, remaining, as it were, at the stage of tubercular formation. The *origin* of tubercle can be conceived to take place only in a *blastema* exuded from the adjoining capillaries. This *blastema*, effused in a fluid condition, infiltrates the tissue, and, advancing from one point, will spread uniformly in all directions; on this account, the most usual form assumed by it will be the spherical. The organized new-formation must, consequently, be deposited among the elements of the tissue, and the transition from the fluid condition into the solid will take place, partly in consequence of the organization, in part, directly, in the protein-substances and (earthy) salts.

The organization is mostly limited, as has been explained above, to that of the *nucleus*, which is frequently surrounded

with a hyaline, often granular substance—the future cell-contents. A cell-membrane is more rarely formed. This is probably owing to the rapid solidification and disintegration of the protein-compound, since so much fine molecular matter and free fat is met with in tubercle. But the non-nucleated, flattened, granular bodies termed tubercle-corpuscles by Lebert, would seem to be formed in another mode. They have an investing membrane, preceding the formation of a *nucleus*, unless we should be disposed to assume that the *nucleus* has become aborted.

The *fatty degeneration* of tubercle consists in the deposition of much free fat in the form of larger or smaller globules. The substance thence assumes a yellowish colour, and its consistence is gradually rendered softer. The organic elements, however, remain. Even in cases where the softened tubercular mass is liquefied, they may still be observed. From this it is obvious, that softened tubercle, as a new-formation, cannot be deemed to possess any solvent properties; and that the solution of the surrounding tissue is rather to be referred to the repeated exudations.

This yellow tubercle has been regarded as a secondary form of the grey, a view which, in many cases, is undoubtedly correct, and wholly in accord with the fatty metamorphoses of normal and of new-formed structural elements; but it is very probable that the remains of the protein-compounds, which have not been used in the formation of the organic elementary parts, may at once undergo fatty degeneration; and, consequently, that it is not absolutely necessary that the yellow tubercle should have previously been of the grey kind; important analogies with this, will be found in cancer.

Tubercle undergoes a favorable metamorphosis, when, its further development ceasing, it wastes by the withdrawal of the nutritive material. It becomes drier, the organic elements unrecognizable, and its consistence cartilaginous; at the same time, calcareous salts are deposited among the mass constituted simply of an amorphous flocculent material. This kind of atrophy, according to Rokitansky, occurs in grey tubercle, whilst *cretification* is the metamorphosis peculiar to the yellow form. In this case, the calcareous salts are usually found in larger amount at the periphery, whilst in the centre a pul-

taceous, friable substance is collected, enclosing much free fat, aggregated fat-globules, brownish-black pigment-masses and plates of *cholesterin*.

Softening is an unfavorable metamorphosis of tubercle. This change proceeds either from the periphery, or from the centre, the difference being determined, probably, by special causal conditions. It can scarcely be doubted that tubercle, like every other new-formation, requires a certain amount of nutritive material for its further growth, or even for its maintenance, which is afforded by the surrounding blood-vessels. Now, if repeated exudations take place around the tubercle, and if the effused products are incapable of further development, but degenerate immediately after they have been secreted, a peripheral softening of the tubercle would necessarily ensue. On the other hand, in the case of a tubercle of considerable bulk—of the size of a lentil or pea, or more—it is easily conceivable that the nutritive matter afforded to it will no longer suffice for the maintenance of the whole tubercle in *statu quo;* and the parts most distant from the periphery—the central, namely,—will undergo a retrograde metamorphosis, and become softened.

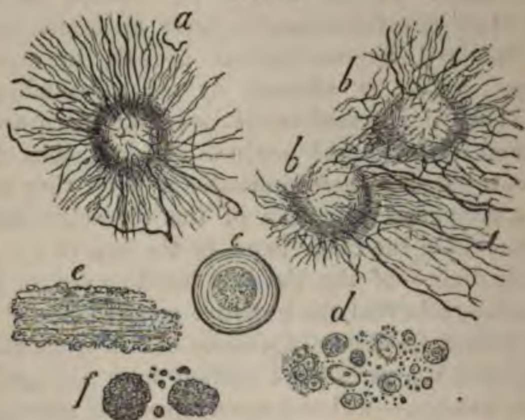
When the softening has reached the highest degree, the tissue infiltrated with tubercular matter liquefies into a puriform fluid, termed "tubercular pus," but which differs, morphologically, from true pus, inasmuch as it does not contain corpuscles corresponding with those of perfectly developed pus, but, mostly, solitary molecules, masses of fat-globules, *nuclei*, and incomplete cell-formations. To which are superadded portions of the tissue killed by the infiltration, and which may occasionally be recognized in the fragments left of them. The process of disintegration set up in consequence of the softening, appears, as it were, to infect the surrounding tissue, for fresh tubercular infiltrations are always remarked in it, and the ulcer thence acquires its thickened or callous border.

Of the *special conditions* presented by tubercle, we shall commence with those presented in the serous membranes, and adduce, more particularly, an instance of tubercles in the *peritoneum*.

They were everywhere seated immediately beneath the serous coat, so that, in fact, the latter was elevated by them. In size, they varied from a little nodule just visible, to that of

a lentil: in the smaller, the colour was greyish, and in the larger, presented a yellowish tinge; their consistence was everywhere dense. Some of the larger ones were surrounded by radiating vessels, from which thicker and slenderer twigs (fig. 68, *a*, *b b*) proceeded towards the tubercular nodule, and

FIG. 68.



gave off oblique and transverse branches. Fine ramuscules also passed across the surface of the tubercle. These vessels are not to be regarded as newly produced, but as belonging to the striped abdominal muscles, the organic muscular fibres of the intestine, and the connective tissue. The elements contained in the secondary product (*d*) were chiefly *nuclei*, the larger of which, of an oval form and presenting a *nucleolus*, were 0·044‴ in their longer diameter; the smaller, which were rounded, were, some of them, not more than 0·0017‴ in size. Many isolated *nuclei* were seen to be surrounded by a group of molecules, which moved with the *nucleus*, and consequently were intimately connected with it. This investing substance was especially evident around the larger *nuclei*. It has already been stated, that the matter surrounding the *nucleus* might be regarded as a portion of contents in process of formation, around which the future investing membrane would appear to be formed. Non-nucleated corpuscles (Lebert's tubercle-corpuscles), and minute nucleated cells, existed only in very small quantity. Among these incompletely developed, organic

new-formations in the tubercle, numerous elementary granules of the most minute size were interspersed. In the more compact portions, flocculent streaked masses were evident (*e*), consisting of a coagulated protein-substance, and in but a few instances, concentric colloid-corpuscles (*c*) occasionally with a granular central mass. Towards the periphery of the tubercle, yellowish-brown collections of fat-globules (*f*) were visible, together with granules either isolated or collected into very small groups. Many tubercular granulations, of the size of millet-seeds, exhibited a slate-grey ring containing sometimes free, large, dark reddish-brown pigment-molecules, sometimes reddish-brown, irregular, flattened corpuscles (retrograde remains of blood).

The coloured border might have been formed from blood either extravasated or which had undergone metamorphosis within the vessels, or from *hematin* which had transuded from them.

That a sanguineous congestion of this kind, readily followed by minute extravasations, takes place during the rapid formation of tubercular granulations is also seen in other serous membranes. In fig. 69 is represented a portion of the phrenic *pleura*. The blood-vessels beneath the serous investment are so congested that a close network of variously convoluted branches is apparent. At *a a*, are seen two tubercular nodules, transparent by transmitted light, and of a greyish colour. Over these run several delicate vessels, which do not, however, penetrate into the interior of the tubercle. At *b*, is a somewhat larger nodule divided into two by a transverse extravasation of blood. The hemorrhagic effusions are of very various dimensions, and usually of an oval form; at *c, d, e*, are seen extravasations of this kind, differing in size; of which those marked *e*, are scarcely visible to the naked eye.

FIG. 69.

The blood escapes into the subserous tissue, and consequently is covered by the delicate *pleura*, which prevents the entrance of the blood into the cavity, and by its resistance soon puts a

stop to the hemorrhage. Sanguineous suffusions of greater extent, of course, take place, only when a larger vessel is ruptured. The blood thus removed from circulation necessarily dies, and will thereupon pass through the various metamorphoses attending the formation of pigment, and may induce a blackish coloration of the partially enclosed tubercular nodule.

Tubercles of smaller size, which, when of about the dimensions of a millet-seed, are usually termed *miliary*, may, also, best be examined in the serous membranes, with respect to their transparency. For besides those of the above-described, usually greyish, clouded kind, there are also hyaline tubercles containing a glutinous fluid, which might readily escape careless observation, since, as clear minute vesicles, they differ but little from the tissue in which they are lodged. A contrast to this transparent kind is afforded in the opaque tubercles, which are more obvious from their white or whitish-yellow colour.

The hyaline tubercles are most probably of younger age, and occasionally contain more perfect cells, and often cells with several *nuclei*.

Even when the tubercle is of minute size, it may, nevertheless, be shown that it never originates as an interstitial growth. It can never be enucleated, as it were, but is always intimately connected with the surrounding structures, sometimes with the superjacent serous membrane, sometimes with the subserous tissue. If the serous membrane be raised, the tubercular granulations remain adherent to it, nor can any sharply-defined limits be remarked around them, which, however, would necessarily be the case had they been enclosed, for instance, in a capsular tunic. Their contours, on the contrary, are blended with the surrounding substance. To this may be added the circumstance that in tubercles of a little larger size (that of a pin's head) connective tissue may be observed included in them.

If the portion of a serous membrane investing a tubercle of the more consistent sort be dissected off, and compared with the adjacent portions, the spot corresponding to the tubercle will be seen to present a brownish-yellow colour; and the fibrous structure will be, there, less easily demonstrable than elsewhere.

Tubercles of the mucous membrane, as is well known, have

their principal seat in the lower part of the small intestine. In this situation, they are lodged, originally, in the submucous tissue, but elevate the mucous membrane stretched over them, as in the serous membranes, projecting, in the form of nodules of a yellowish colour, and usually assembled together into several groups. In most cases, owing to the production of new tubercular granulations between the older ones, a fusion of the new-formations appears, ultimately, to take place; and these deposits, particularly in the intestine, exhibit a great proneness to degeneration. They are usually of soft consistence, and contain, besides the usual elementary constituents, an abundance of free fat. In the case of an individual affected with miliary tubercles in the lungs, and tubercular inflammation of the right knee, yellowish nodules, varying in size from a pin's head to that of a bean, existed in the lowermost part of the small intestine; they were seated in the sub-mucous tissue, and, together with *nuclei* and imperfect cell-formations, contained elements strongly resembling those met with in *fungus medullaris.* They represented comparatively voluminous forms of various kinds, oval, with a longer or shorter process (caudate corpuscles, as they are termed), ventricose, fusiform cells, with short processes, others rather more slender, with long extended processes. All these elementary organs occurred in an advanced state of fatty degeneration of their contents. We shall afterwards refer more particularly to the analogies between tubercle and cancer, deeming it best to pass over their consideration in this place, as the other term of comparison is wanting.

The tubercles deposited in the submucous tissue of the intestine impede the circulation of the blood in the superjacent portions of the membrane, and gradually destroy its vitality in those situations, the destruction being accelerated by the softening of the tubercular substance. The newly-formed elements of the latter are mixed with the fragmentary remains of the mucous membrane, and, owing to their loose attachments, are readily thrown off. The intestine in these situations is deprived of its mucous membrane, and ulcerations are formed whose shape depends, simply, upon that of the precedent tubercular infiltration. In the case of a single tubercle, which, after softening, has been thrown off, together with the superimposed mucous membrane, the result is a crateriform ulcer;

but when a number of contiguous tubercles are fused, as it were, into one, the sloughing of the common mass, together with that of the corresponding portion of mucous membrane, produces an extensive ulceration, with irregularly excavated borders. The deposition of tubercular matter is continued at the margins of the ulcer, whence arises the thickened border, so characteristic of these lesions. The ulceration goes on by the continual softening of the infiltrated border, and frequently attains to a considerable size. The deposition of the tubercular new-formation, however, not unfrequently continues, also, on the floor of the ulcer, and in the same way as, when deposited in the submucous tissue it destroys the mucous membrane *centripetally* or towards the axis of the intestine, so, in the present case, the deposition ultimately entails the destruction of the organic muscular layers, and, lastly, of the peritoneal coat, in a *centrifugal* direction.

The floor of the tubercular ulceration in the intestine presents merely organic *detritus* in the form of rounded, oval, or elongated *nuclei* (the latter belonging to the organic muscular fibres), molecular material of a dirty brownish-yellow colour and fibrils of connective tissue, which, however, are so concealed by the molecular matter as to be distinctly visible, only here and there at the edges. Besides these elements, numerous, amorphous, coloured matters occur, referrible to the necrosed blood, and which cause the slaty-grey coloration of the mucous membrane; they are probably constituted, for the greater part, of minute extravasations, which occur in considerable abundance associated with the vascular congestion.

The *lungs*, as is well known, are, not unfrequently, the seat of miliary tubercles, which are distributed in all parts of the substance of the organs. The question now arises, as to whether these deposits take place in the parenchyma itself of the lungs, or, to some extent, merely in the interstitial connective-tissue. It is not difficult to perceive that the ultimate pulmonary vesicles are also involved in the tubercular infiltration, as was long since pointed out by Gluge. For if a granular tubercle of the kind in question be dissected out, and torn in pieces, by means of needles, the appearances depicted in fig. 70 will be presented. The fibres of the pulmonary tissue, readily recognizable by their characteristic curves (*c*), and

which correspond to the peripheral borders of the air-cells, are everywhere visible in the adventitious deposit, but are so concealed in its denser portions as not to be distinctly visible until the mass has been acted upon by an alkaline carbonate. The elements enclosed in the air-cells, and completely filling them, are sometimes flattened corpuscles (*a*) in which a *nucleus* may occasionally be distinguished. But more frequently when the cells are ruptured, nothing escapes from them, but rounded or oval *nuclei* (*b*) often surrounded with a circlet of minute molecules. These constituents, *a*, *b*, should not, perhaps, be regarded as wholly of new-formation, as it is well known, that the internal lining of the air-cells is constituted of an epithelium, whose cells are like *a* in form, with *nuclei* not unlike *b*. Thus, although in the air-cells infiltrated with tubercular matter, the newly formed elements cannot be certainly distinguished from the disintegrated *epithelium*, still we think it would be wrong to conclude that the elements contained in miliary tubercles of the lung merely represent the disintegrated *epithelium* of the air-cells. In the case of tubercles in the serous membranes we are satisfied that new-formations exist (*vid.* fig. 68, *d*), similar to those found in the pulmonary cells; a circumstance rather in favour of the assumption that the elements represented in fig. 70, *a*, *b*, should be regarded as, in part, at any rate, of new-formation.

Fig. 70.

In miliary tubercles of a yellowish colour, numerous fat-globules are seen in the fine-molecular, interstitial substance in which the new-formed elements are imbedded. When the consistence is, at the same time, diminished, the substance of the tubercle will be more readily compressed between two glasses, and the pulmonary fibres, although still distinctly recognizable as such, will be seen to have lost to some extent their peculiar arching curves. It is very usual, also, in these nodular deposits in the lungs, to find free, black pigment appertaining probably to the pulmonary tissue. For it is well known that a considerable amount of pigment exists in the interstitial tissue

of the air-cells, in the physiological condition, which is subsequently enclosed in the tubercular infiltration, and appears in them as a colouring material.

Miliary tubercles are also seen in the lungs, aggregated into considerable groups, and softening down into a yellowish, pulpy substance occupying the whole of a lobule, by whose limits it appears to be bounded, and exhibiting, even to the naked eye, numerous black points of pulmonary pigment. The consistence of these agglomerated tubercles is less than in the other form, and when they are wholly coalesced into one mass, it becomes soft and pultaceous.

The pulmonary lobules, when infiltrated with tubercular matter, are distinctly perceptible on the surface, and in sections of the lungs. The yellowish, soft substance of which they are composed, contains: 1. Elements (fig. 71, *a a*) analogous to those which we have noticed as existing in the solitary, miliary tubercles in the lungs (fig. 70, *a*, *b*). 2. Numerous brilliant fat-globules. 3. Remains of the conical, ciliated cells, by which the bronchial twigs are lined. 4. Thick bundles of pulmonary fibrous tissue (fig. 71, *b b*). The latter are found in the expressed pultaceous matter, usually in a state of complete disintegration; and only occasionally presenting the aspect of elongated, puckered or arching fibres. In this case, consequently, mortification of the pulmonary tissue had taken place.

FIG. 71.

When the tubercular new-formation is more extensive, and the softening involves several contiguous lobules, a cavern is produced, containing portions of dead pulmonary parenchyma together with broken up tubercular matter, and whose walls, on the other hand, consist of the pulmonary tissue infiltrated with tubercular deposit, and in a state of disintegration.

The inner surface of the cavern is covered with a dirty-yellow, grey or greyish-red fluid of a syrupy consistence, and containing merely a granular matter, in which nuclear corpuscles constitute the only organic remains. This fluid is frequently very viscous, and then presents an abundance of threads of *mucin*.

When the organic *detritus* is not so completely disintegrated, detached pulmonary fibres may be seen in the pultaceous contents of the cavern, and may be readily recognized by the peculiar way in which they are curved. These fragments should be looked for in the *sputa* of phthisical patients, and are of diagnostic importance, as indicating a loss of substance of the pulmonary parenchyma. According to Schröder van der Kolk, they are more likely to be met with in the sputa, in cases when small caverns exist in a state of progressive development, than where larger ones are present, in the advanced stage of *phthisis*.

Beneath this layer of thick fluid, lining the inner surface of the cavern, Lebert describes the frequent occurrence of false membranes, often in the form of mere *flocculi*, though usually of more extensive layers of elastic consistence and yellowish colour, and composed of a striated substance containing numerous pus-corpuscles. These false membranes are rarely, closely adherent to the subjacent tissues, nor did Lebert ever notice them to be connected by means of newly formed vessels.

The layer, exposed by the removal of the fluid secretion, and of the false membrane, has been termed the "pyogenic layer" by Lebert. It is of a reddish colour, with a velvety surface, having an intimate vascular connexion with the subjacent pulmonary tissue, and presenting an irregular fibrous structure. It frequently contains but few vessels, and in proportion to this paucity is the fibrous tissue closer, sometimes presenting almost a cartilaginous aspect. This newly organized membrane lines the caverns, frequently over a pretty considerable extent, and, in rare cases, quite up to the entrance of the *bronchiæ*, with whose mucous membrane it bears some resemblance. Its perfect organization, however, is usually prevented by the subsequent tubercular excrescences, and this circumstance is regarded by Lebert as one reason why tubercular caverns so rarely close. He looks upon this membrane, which we regard as a superficial, newly formed connective tissue, as an attempt at healing, on one hand, by its protecting the ulcerated surface from the direct influence of the air, and, on the other, by its causing the cicatrization of the cavity. In proportion as the cicatrization advances the tissue of the immediately adjacent portion of the lung is also rendered denser, and in the atrophied condition assumes a callous consistence. The air-cells, in this situation

are, for the most part, no longer to be recognized, appearing to be replaced by flocculent masses mixed with fat, indistinct nuclear bodies, the remains of elastic fibres and pigment. Concentric colloid-corpuscles in small numbers are imbedded in the indurated and condensed portions of the lung. These parts, also, not unfrequently contain earthy concretions, which have been regarded as cretified tubercular masses; besides the amorphous calcareous salts partially soluble with effervescence in acetic acid, and with sulphuric acid forming crystals of sulphate of lime, these concretions contain much fat in the form of globules and broken *cholesterin* plates; nuclear bodies imbedded in a brownish-yellow molecular substance, may also be recognized in them.

It is well known, that the formation of aggregations of tubercles in the lungs is usually attended with a catarrhal affection of the bronchial mucous membrane, in which, and not in any caverns in the pulmonary parenchyma, is the true source of the *sputa* to be sought. Formerly, and before any precise morphological investigation of the subject had been undertaken, it was thought, that the abundant, liquid *sputa* in *phthisis* were derived from the softened, pulmonary substance and tubercular matter; but microscopic examination will only rarely discover the presence of the pulmonary fibrous tissue, which may be deemed an indisputable evidence of the death of portions of the parenchyma of the lungs. Whilst, on the other hand, if the molecular material in the *sputa* be regarded as tubercular matter in the liquefied condition, the assumption will be irreconcilable with the circumstance, that the same abundant molecular material also occurs in simple bronchial catarrh, independently of *tuberculosis*.

The principal constituent in the expectoration, in pulmonary *tuberculosis*, is formed by pus-corpuscles, which are suspended, in great numbers, in a partly hyaline, partly streaky matrix (*mucin*). The addition of acetic acid produces a remarkable degree of opacity in these *sputa*, due to the precipitation of the *mucin* in the form of straight filaments; whilst the fine-molecular matter, occasionally forming denser masses, is unaltered by it.

The amount of fat-globules is increased, especially in the dirty yellowish-green, fluid *sputa* in the last stage of *phthisis*.

These globules float on the surface when the *sputa* are mixed with water, and may also be seen forming aggregate masses.

The same kind of globules, containing a finely granular, occasionally coloured matter, as occur in pneumonia, also exist in pulmonary *tuberculosis* (*vid.* fig. 66, the three non-nucleated, larger, granular globules). Blood-corpuscles, likewise, as is well known, are very frequently present in the *sputa*, and, unless aggregated into considerable, coherent masses, are scarcely of any particular pathological import, since they are also presented in simple catarrh.

Höfle has lately, again, drawn attention to the circumstance, that solitary, yellowish-white, tolerably firm, oval masses affording a fetid smell when crushed between the fingers, are occasionally hawked up from the *trachea* and *bronchiæ*, by both healthy and diseased individuals, which have heretofore frequently been regarded as crude tubercles. Upon microscopic examination, he found a confirmation of Laennec's statement, that these masses were derived from the mucous follicles of the tonsils, since they were constituted for the most part of *epithelium* (indeed, from our own observation, of the large, flattened, epithelial cells of the oral mucous membrane), pus-corpuscles(?), oil-drops, and solid, amorphous fat.

In hypertrophied tonsils, cretified bodies of the same kind are known to occur, not unfrequently, a circumstance also noticed by Höfle. Many of these tonsillary concretions have, doubtless, been regarded as *sputa cretacea*, since they are sometimes coughed up, and sometimes got rid of by hawking.

Miliary tubercles in the subperitoneal tissue of the *liver*, present the appearance of numerous nodules slightly projecting above the smooth surface, the peritoneal investment remaining unaltered. They cannot be regarded as belonging to the *peritoneum*, since they exhibit a peculiar structure. For if they are examined with a lens of moderate power, a darker spot will be observed in the centre (fig. 72, *a a a*) surrounded by a light *areola*. The central dark part of the nodule is sometimes a mere point, but just perceptible with a magnifying power of 4—5 diam., and is sometimes represented by a circular spot; its outline corresponds with that of the tubercle: when the latter is elongated, so is that of the central spot, and, consequently, the longitudinal axis of the latter

coincides with that of the surrounding light *areola*. And when the outer circumference of the tubercle is indented, as it were, on each side, so that it assumes an hour-glass shape, the dark central part corresponds in form. It is, moreover, worthy of remark, that these miliary tubercles are seated in the vascular, red-brown, dark substance of the liver (*c c*), whilst the lighter-coloured, yellowish substance (*b b*) occupies the interspaces, in the form of irregularly shaped islands.

Fig. 72.

On more close examination, the following particulars are apparent. When the *peritoneum*, at a point corresponding to the situation of a tubercle, is removed by means of a cataract-needle, the little nodule may be raised, and is usually adherent to the peritoneum upon its removal; it consists simply of a molecular substance of a deep-yellow colour at the dark spot, corresponding to the centre of the tubercle (as if coloured by bile-pigment). The yellowish substance (*c c*) presents, both within and without the hepatic cells, of which it is made up, numerous fat-globules, from which is derived the pale, light-yellow colour, when the substance is viewed by reflected light; and which globules are wanting in the reddish-brown portion. For further remarks on this subject, we must refer to the form of nutmeg-liver described under the head of "atrophy" of that organ.

A question now arises, as to the nature of the dark spots observable in the centre of these tubercles. The deep-yellow coloration renders it, perhaps, most probable that bile-pigment is there accumulated. Whether the bile be accumulated in the simply dilated extremity of a biliary duct retaining its presumed walls, or whether it be left in the central portion of the tubercular infiltration after a rupture, of some kind, of the latter, we are the less able to determine, since the relations of the peripheral bile-ducts to the hepatic cells have not yet been made out.

These subperitoneal tubercles also occur in the form of hyaline, circumscribed vesicles, about the size of a pin's-head, and scarcely projecting above the surface; which, as they become opaque from the centre outwards, assume a firmer consistence, and are more prominent.

Tubercles imbedded in the midst of the hepatic parenchyma are more rare. In the case of an old woman who had tubercular caverns in the lungs, isolated nodules, varying in size from that of a lentil to that of a pea, were found in the liver; they presented a consistent, light-yellow coat, and grass-green, soft, semifluid contents. The organic constituents of the latter appeared to be rounded *nuclei* containing a few molecules, and occasionally beset, probably externally, with fat-globules; they underwent no change in acetic acid, and, in form and size, corresponded in all respects with the *nuclei* of the hepatic cells. Together with these bodies, the proper, main element of the softened substance was, simply, molecules, amongst which, deep-yellow bile-pigment was deposited in amorphous masses. In nodules recently dissected out, the remains of deeply-coloured hepatic cells, in a still better state of preservation were found in the central, softened substance; so that there could be no doubt that the substance in question represented an organic *detritus* of the hepatic parenchyma. The compact, almost cartilaginous case of the nodules presented a large amount of young elements of cellular tissue with connective-tissue-fibrils, as it seemed, towards the periphery, whilst, more internally, a flocculent substance with scattered fat-globules of large size was presented. The consistent, miliary tubercles do not present the yellow central substance, but, morphologically, resemble the others.

From tubercles of the liver, Rokitansky distinguishes certain cavities, usually of the size of a millet-seed to that of a pea, which frequently occur isolated, and are filled with a viscous, mucilaginous, or gelatiniform fluid, mostly of a dirty-green colour, often presenting several secondary sinuosities, and, after the evacuation of the fluid, exhibiting a smooth wall. These cavities occur sometimes together with tubercles in the liver, sometimes independently of them, especially in fatty livers, associated with the deposition of tubercles in other organs. The above-named author regards them as dilatations of the

capillary, biliary vessels, their walls being flaccid, and since they do not present the secondary tubercular deposits which elsewhere accompany the softening of tubercular masses. We have only a solitary case of this kind recorded, and observed in the thick fluid material merely a molecular substance with larger and smaller granular masses, isolated fat-globules, and orange-yellow *plaques*. Consequently, the rounded *nuclei* of the hepatic cells were wanting, which would have indicated a disintegration of the parenchyma of the liver.

Miliary tubercles, when apparent on the surface of the *kidneys*, are attended with a hyperæmic condition of the cortical substance; the stelliform venous ramifications, and capillary plexus surrounding the tubercular granulations, are especially well seen. In fig. 73, *d*, is shown the point of union of several peripheral, venous ramuscules, running in the grooves on the surface of the gland. These veins arise from a capillary plexus, surrounding the superficial *tubuli uriniferi*; in which plexus, as at *a*, *b*, *c*, grey, rather prominent tubercles may be seen. The congested capillaries, however, appear to have pale interspaces left among them (*f*, *f'*), not only around the tubercles, but in other spots also. Besides these, may be perceived transparent, yellowish-red, glistening points, about the size of the little circles marked *e* in the figure; these points are distributed in regular order, and represent the *glomeruli Malpighiani*. Hyperæmiated kidneys of this kind always appear granular on the surface, frequently without exhibiting any other metamorphosis of the parenchyma. The granular condition in this case depends simply upon the contiguous groups of *tubuli uriniferi* partially surrounded by vascular zones, and which are more prominent than usual, owing to the general turgescence of the organ.

Fig. 73.

These miliary tubercles also occur more deeply seated,

especially in the cortical substance, and contain, besides a predominant molecular, flocculent material with scattered brilliant molecules, nuclear bodies belonging to newly-formed (?) oval cells, sometimes of comparatively large size, sometimes of smaller dimensions.

The aggregated tubercles of the kidney undergo softening, in consequence of which a considerable portion of the renal parenchyma is destroyed, nothing remaining, ultimately, but a cavity, whose walls are infiltrated with tubercular matter.

Tubercular deposit in the *brain* is characterised by its dirty light-yellow, sometimes greenish colour, the dense, sometimes friable texture, and its unequal consistence. Amongst organic elements are *nuclei*, sometimes rounded, sometimes more angular, which occur, in very great abundance, imbedded in a fine-molecular substance. Besides these, especially towards the periphery of the tubercle, and in its immediate neighbourhood, we find oval, or conical, finely granular corpuscles, sometimes having a diameter of 0·007‴; and in the interior of many of which an excentric *nucleus* may be perceived. The softer, central substance of cerebral tubercles presents dirty yellowish-brown, reddish-brown, and black pigment-masses, granule-masses, and fat-globules.

We have several times had an opportunity of examining tubercle in *bone*, and especially in an interesting case, in which an extensive tubercular mass, external to the *dura mater*, and manifestly arising from the bone, enclosed several particles resembling grains of sand, which proved to be osseous fragments; a proof that in this situation also, the tubercular new-formation takes place in the parenchyma of the bone, and induces a secondary detachment of the necrosed portions of osseous tissue.

Having thus described some of the special relations of tubercle, we shall proceed to some general considerations with respect to its *nature* and *pathological import*.

Virchow has propounded a general definition of tubercle, under which term he understands a metamorphosis of the tissue, produced by a destruction of the cells, whether the tissue be old or, as it is termed, physiological, or pathological and of new-formation. The tubercular metamorphosis, according to him, consists in an arrest of nutrition, in a mortification or

necrosis. In his view, therefore, tuberculization, is, in other words, an atrophy (involution) of the original or of a newly-formed pathological tissue.

We think it improper to extend the definition of tubercular formation so as to include simple, genuine atrophies, as by so doing we needlessly place ourselves in opposition to the meaning entertained by other authors, who, under the term "tubercle," always understand a new-formation presenting special characters, in its anatomical relations, in the mode of its origin, and in its course. We also look upon it as indispensable, to have regard to the genetic impulse, inasmuch as, whilst, in simple atrophy, the organ undergoes a change of form in consequence of want of nutriment, in the tubercular formation, a deficiency of formative capacity in a newly-formed blastema exists; the organ, consequently, as such, does not enter into consideration at all. Simple atrophy, lastly, in each organ, occurs under particular modifications; if we compare, for instance, the atrophy of bone with that of the liver, the process in the two cases will be found to exhibit variations, such as do not occur in tubercle in different organs, as, for instance, in the brain, lungs, liver, and kidneys; in all these situations the same fundamental character of form remaining.

The extension of the idea of tuberculization to various new-formations, such as pus, cancer, sarcoma, &c., as proposed by Virchow, appears to us to be the less allowable, since pus, cancer, sarcoma, &c. differ from tubercle in the aggregate of their morphological characters, but especially in their evolution and course. The application of the definition of tuberculization to the various forms of involution of pus, cancer, and sarcoma, manifestly leads to the idea that these new-formations become tubercles, a notion, however, which is certainly opposed to their whole character.

Having thus, and for the above reasons, shown, that we adhere to the original notion of tubercle, and at once disclaim for it any positive, characteristic, elementary forms, it is incumbent upon us to assign the *characters* of tubercle in general terms.

These are as follows:

1. *A low degree of organization* of the new-formation; it being limited chiefly to the formation of *nuclei*, and of incomplete cells. The more fully developed cell-formations occa-

sionally met with in tubercle, are, relatively speaking, scanty in number, and deposited towards the periphery of the new-formation; and they may also, as is mostly the case, be altogether wanting, the formation still retaining the tubercular character; they are not, consequently, an essential constituent. To employ the term "tubercle-corpuscles," as proposed by Virchow, for the shrunken *nuclei* is, in our opinion, unadvisable, since, as he himself says, there is no special characteristic element of tubercle, and yet such would be implied under the proposed term.

2. *The continued development of the tubercle from a parenchymatous infiltration,* in consequence of which the included tissue is destroyed. In the present state of knowledge, we are not justified in assuming any specific exudation in the tubercular formation; but must confine ourselves solely to the products arising from the exudation. These, at once show, that the tuberculization does not take place at all in the interstitial connective tissue of an organ, but in its parenchymatous portion. That an exudative process precedes the tubercle, is seen in those hyaline, gelatiniform, tubercular granulations, which are more especially evident in serous membranes, but which cannot be described as a simple mortification, or necrosis of the tissue. We agree, therefore, with Rokitansky, and, in his fundamental view, with B. Reinhardt, who regard tubercular deposits as products of inflammation, though dissenting from the latter in considering tubercle to be disintegrated pus.

3. *Spontaneous disintegration,* in which the tissues, involved in the parenchymatous infiltration, as well as the newly formed organic elements, are subjected to a process of solution. With respect to which it should be remarked, that the exudation may perish at once, or *ab initio,* before it has attained to the character of a new-formation. In an instance of this kind, therefore, in accordance with our definition of tubercle, the disintegrated exudation cannot be described as tubercular, but we are compelled to conclude, solely from the presence of contiguous, fully developed forms, that we have before us an undeveloped tubercle.

4. *A peripheral (secondary) formation of tubercular substance* is found to take place universally, where the deposit is

undergoing the process of softening. Tubercle, therefore, whilst wasting on one side, waxes on the other.

The *malignancy* of tubercle resides in the characters described under 2, 3, 4, since, by these properties of the deposit, a direct, widely-spreading destruction of the affected organ is brought about.

IV. NEW-FORMATIONS IN THE TYPHOID DEPOSIT.

We associate these new-formations with tubercle, which they resemble in their degree of development; and will commence at once with the histological analysis of the greyish-red, succulent, soft masses which are deposited in well-marked cases of *typhus;* and which occur sometimes in the Peyerian patches between the mucous membrane and the muscular coat, sometimes in the latter, and in the subserous tissue of the small intestine, as well as in the mesenteric glands. This substance, which, to use Rokitansky's expression, presents the most striking resemblance to encephaloid growths, was procured, in the instance here described, from isolated tumours, varying in size from that of a lentil to a hazel-nut, in the mucous membrane of the lowermost portion of the *ileum.* These little tumours, when divided, presented a faint, rose-red colour, were lodged in the submucous tissue, and on pressure afforded a milky, turbid juice, in which the new-formed elements were suspended. The cells mostly presented an oval form, many being more or less angular; they contained, sometimes only a single, excentric *nucleus* (fig. 74, *a*), of an elliptical or rounded shape, with a *nucleolus,* occasionally very distinct; sometimes, in the larger cells, two, three, or four *nuclei* were visible (fig. 74, *b b*), whose unequal sizes, and usually excentric position were remarkable. The contents of the cells were mostly finely granular, and occasionally fat-globules were apparent in them, as at *c,* which may even occur in such numbers as to conceal the *nucleus,* and occupy the entire cell. The diameter of the cells varied between 0·00354

Fig. 74.

—0·1062‴, and that of the *nuclei* between 0·00132—0·0035‴. Besides these predominant, elliptical forms, fusiform cells (*d*) were also visible, containing a comparatively large, oval nucleus, with a well-marked *nucleolus*. That the latter elements were of new-formation, and did not belong, in any way, to the organic muscular fibres, is evident from their outline, but especially from the large, elliptical *nucleus*. The intermediate forms, between the elliptical and fusiform cells, and the latter themselves, existed in trifling numbers.

These morphological elements, however, are not, commonly, so well marked. The most usual constituent found in the typhoid deposits, besides nuclear bodies, are only the flattened tri- or quadrangular, granular forms, unaffected by acetic acid, which have been described by Lebert as specific tubercle-corpuscles. We remember a case in which they existed in great quantity in the copious, typhoid infiltration from the small intestine of a Horse.

The organic new-formation ceases to be recognizable in the coating which is adherent to the surface of typhoid ulcerations of the intestine, as is shown at *a*, in fig. 75. It contains *nuclei* of various sizes, and a few elliptical, nucleated cells imbedded in a finely molecular material, with floating fat-globules. These organic elements may in this situation represent the remains of *epithelium*, and of the Lieberkühnian glands. The other elementary organs represented in fig. 75, were afforded by a typhous, mesenteric gland infiltrated with a soft, succulent matter, partly of a greyish-red, partly of a yellowish colour; it contained rounded, or polygonal cells, with one, two, three, or more *nuclei*; and the cell-contents, in many of them, were in a state of fatty degeneration, in fact, so much so that the *nuclei* were perceptible only as lighter-coloured spots. In those cells in which the fatty degeneration was still more advanced, the cell-membrane was destroyed, the coherent fat-granules constituting the outer border. These cells, therefore, resembled a granule-mass, with one or several, light-coloured spots corresponding to the *nuclei*. That the elementary organs here represented in the

Fig. 75.

mesenteric gland, thus infiltrated with typhoid deposit, were of new-formation, is evident from the examination of those glands in the normal state, in which similar elements are wanting. With respect to this, however, we must, in addition, remark, that an organic new-formation of this kind is only to be sought in well-marked cases in which the typhoid deposit presents the characters above described.

The organization of the exudation, which is deposited in *typhus* in the submucous tissue, and in the Peyerian and mesenteric glands, is limited, as it would seem, in many cases, simply to the formation of *nuclei*. We have several times had occasion to observe, in the abundant typhous infiltrations in the mucous membrane of the stomach and *duodenum* in the Horse, a considerable accumulation of rounded and angular *nuclei*, disseminated in a fine-molecular material, which latter could not be referred merely to mortified normal tissue.

In other cases, the exudation in *typhus* undergoes no organization at all, nothing being presented but a viscid fluid having a bloody tinge, containing, of solidified protein-substances, merely a fine-molecular matter, and occasionally groups of very minute, orange-coloured hematoidin-crystals, visible only by strong magnifying powers; together with necrosed, red blood-corpuscles, which no longer yield their colouring matter to water.

The thin fluid exudation, thrown out in *typhus* on the surface of the intestinal mucous membrane, causes the *epithelium* to be detached, but undergoes no further organization. The bloodless *villi*, deprived of their *epithelium*, frequently shrink considerably, so as to present the aspect, simply, of slender, sharp-pointed processes, with granular contents; but should they, in other situations, retain their normal form, a dark, brownish-yellow molecular material, with scattered granule-masses, will be noticed, especially at the apices of the *villi*, as we have already remarked in speaking of the process of exudation (*vid.* fig. 49, *c*).

In reviewing the newly formed organic elements in *typhus*, as little of a characteristic and specific nature will be observed in them, as in tubercle. The organized, typhous exudation cannot, in many cases, be distinguished from tubercular matter, whilst, in other instances, it bears a decided resemblance

to medullary cancer. The pathological import which these more perfectly developed cell-formations bear with respect to any determinate form of *typhus*, cannot at present be assigned; but in any case the multi-nucleated cells indicate a rapid multiplication and active production of organic elements, in the same way as the fatty degeneration is indicative of a rapid involution or destruction of the organized material, which, in the mucous membrane, is productive of a partial necrosis of the tissue. In consequence of this, the portions of mucous membrane corresponding to the infiltration are thrown off, and ulcerations established differing from those of tubercular origin in the circumstance, that unlike the latter, they are not attended with a secondary infiltration in the parts surrounding the ulcer; whence again, the borders of the latter appear smooth and even.

V. NEW-FORMATIONS OF CELLULAR (CONNECTIVE) TISSUE.

The wide distribution of cellular (connective) tissue in the organism may be regarded as a reason why new-formations of a similar nature are met with so frequently and in such a variety of organs. The *character* of these formations depends upon the following principal types:

1. The formation of *embryonic connective-tissue-elements*, for the determination of whose true nature it is necessary to have a continuous series, since, owing to the possible confusion of the isolated, elementary constituents of the cellular (connective) tissue with other elementary organs, the *diagnosis* of them is never possible, with any degree of certainty, from a single cell. The two principal forms of immature connective tissue are the *rounded* and the *fusiform*, between which very numerous intermediate and derivative forms exist. The rounded, as well as the fusiform, connective-tissue cell is furnished with a membrane usually enclosing a fine-molecular matter, and presenting in its interior one or two *nuclei*. The latter, of a round, oval, or ellipsoidal shape, contain one and sometimes two *nucleoli*. The intermediate forms between the rounded and the fusiform arise in the equal or unequal elongation of one axis at the expense of the other; it is in this way that are produced the

oval, ellipsoid, singly or doubly caudate cells. From the fusiform cells, (fusiform corpuscles, fibre-cells,) derivative forms arise with three, four, or more processes, whence, ultimately, the stellate cells are produced. The elementary organs of the embryonic connective tissue originate in a hyaline *blastema* in the form of scattered corpuscles, though appearing to be aggregated together when the cells have become multiplied by spontaneous division. The fusiform cells arrange themselves together in the direction of their longitudinal axis and surround those of a spherical form.

2. The formation of *connective-tissue bundles*, characterised, as has been already stated in the General Part, by the wavy course of the fasciculate fibres. Isolated filaments torn from their natural relations and connexions cannot, of course, be recognized as fibres of connective tissue, since they are in all respects isomorphous with those of coagulated *fibrin*; attention must therefore always be directed to their fasciculate aggregation. Another distinctive character resides in their behaviour towards acetic acid. We have already mentioned the mode of formation of the bundles of connective tissue from fusiform cells, in accordance with Schwann's theory, and the persistence of the *nuclei* as imbedded corpuscles. Now the latter may be demonstrated by the action of acetic acid, although they are not to be regarded as a constant and prominent phenomenon, appearing to be more distinctly manifested in proportion to the immaturity of the fibrous connective-tissue. Now since the connective-tissue-bundles arise from the fusiform cells, they will surround the spherical and other intermediate forms of cells, although never enveloping them like a closed capsule. In this way are produced the intercommunicating *areolæ* whose form and size, in new-formations of connective tissue of complex structure, exhibit great diversities.

3. When the connective tissue is developed *de novo* on a free surface and therefore towards a cavity, whether the latter be one of the large visceral cavities or a simple *areola* in the tissue, it frequently assumes the form of a *papillary* projection, and of a *dendritic* growth arising therefrom. In serous membranes, as, for instance, on the *peritoneum*, new-formations of connective tissue of this sort are apparent, even to the naked eye, in the form of arborescent, subdividing bands, or as scarcely

visible, sessile nodosities. More delicate ramifications and clavate elevations may be perceived with the aid of a powerful lens, exactly like those discovered by Rokitansky in the so-termed false membranes, a subject upon which we cannot, here, enter further.

The papillary new-formation, with dendritic branching of the bands of connective tissue, is not unlike the arborescent crystallization sometimes seen on the sides of vessels.

The more particular anatomical description will be given in speaking of the special organs, this much only, being here observed, that these structures are very often, hollow, and contain a fluid, blastemic material, from which immature, connective-tissue-elements are produced. We shall afterwards, however, see that other elementary parts, such as fat-cells, cartilage-cells, or even osseous corpuscles, are produced in the *plasma* contained in the cavities; a diversity which in most cases depends upon the character of the fundamental tissue serving as a point of attachment to the dendritic vegetation.

In new-growths of cellular tissue, moreover, newly formed blood is not unfrequently met with in these spaces, presenting the appearance of blood-red streaks within the bands of connective tissue. When a new-formation of this kind consists of an aggregation of papillary growths filled with blood, we have the form known under the name of *teleangiectasis*.

The blastema contained in the saccular cavities frequently undergoes various kinds of degeneration, before becoming organized. Of these may be noticed, especially, an accumulation of fatty molecules, of a dark brownish-yellow, brownish-red, or black pigment, or of a serous fluid in the dilated extremities of the hollows. In the latter case, consequently, is produced a pedunculated cyst. It is a fact, also, that in many cases, deposits of amorphous, calcareous salts take place in the cavity.

The *starting point* of the new-formations of connective tissue in general, appears to be, chiefly, in the connective tissue of the organs. In many cases, however, it is indubitable, that the growth may commence independently, in a secreted *blastema*. The *mode of extension* may be described as twofold.

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1. A *concrete*, in which the new-formation is limited to separate points, and consequently assumes the form of nodules or granulations. These granulations are, not unfrequently, assembled into groups, forming mulberry-like vegetations; the individual groups, also, are often separated by deepish grooves, whence a vegetation of this kind is divided into lobes, and to a certain extent acquires a cauliflower aspect. When more voluminous, and retaining their smooth surface, the granulations and little nodules become *tubera*, such as are seen in fibroid tumours of the *uterus*. It is at once obvious, that the papillary form, with its dendritic branching, belongs to the concrete class.

2. A *diffuse* kind of new-formation of connective tissue is observed when it extends throughout an entire organ. Examples of this are seen in granular liver, and in atrophied kidneys after Bright's disease. In the former case the interstitial connective tissue—the so-termed capsule of Glisson—is hypertrophied; and in the latter also, an increase of the connective-tissue-*stroma* may be observed.

The concrete and diffuse kinds of formation may coexist in one and the same organ; thus nodular new-formations occur in the liver of syphilitic persons; and in like manner they are found in the cysts of the kidney.

Should the new-formations continue to grow, they will require, like all the normal tissues, a constant supply of nutritive fluid, but as this cannot reach beyond a certain distance, a new-formation of vessels with be requisite, for the nutrition and further development of the new-growth. In this way a collateral circulation of the blood is established, and the formation of connective tissue will follow an *independent direction* in the multiplication of its elements.

Under these circumstances, the nutrition is often interfered with, sometimes because the supply of nutritive fluid is irregular, and, sometimes owing to a disproportion between the growth and the nutrition. For more may be produced than can be maintained, and certain portions of the new-formation will be deprived of nutriment—that is, will become atrophied, when they will undergo the same morphological changes as accompany atrophies in general. Thus we have serous degenerations, accumulations of fat in a state of

minute subdivision, pigment, calcareous salts, and wasting of the organized substance.

The new-formation of connective tissue is *not* subject, or only in a minor degree, to *spontaneous involution*, its atrophy being brought about by external circumstances affecting its nutrition. No central softening takes place in it, nor any spontaneous disintegration of the elementary organs, as we have seen to be the case in tubercular matter, and shall show to exist, even in a more marked degree, in *cancer*. This peculiarity, of not being liable to spontaneous softening, is the reason of the so-termed *benignancy* of tumours composed of connective tissue. When they suppurate or soften some local conditions will be found to account for it. Thus, if an extensive new-growth of connective tissue take place in the subcutaneous tissue, the superjacent *corium* becomes thinned, atrophied, and ultimately broken through by the new-formation. If the new-growth is attended with the formation of pus, a bare suppurating surface will be presented, but this should not be regarded as indicative of its softening.

As regards the growth of new-formations of this kind we must especially consider their relations towards the organs in which they lie, or which are within their influence. These organs never present any parenchymatous infiltration, by which a disintegration of the cells of the parenchyma might be produced, but the growth always appears, as it were, to be *interpolated among the parenchymatous* particles of an organ, whence a partial shrinking, and consequent wasting of the latter are induced. In proportion to the extent of the new-growth is the destruction of the parenchyma of an organ, brought about, as it were, by the constriction, and the cutting off of the supply of nutritive fluid. The new-formation, therefore, is the more dangerous the more influential is the organ affected.

It is thence apparent, that little can be said as to the *benignancy* of these growths. If we consider the case of granular liver already referred to, we surely cannot call a new-formation of that kind "benignant;" again, the hideous destruction which follows the ravages of *lupus*, an affection consisting in a new-formation of connective tissue in the *corium*, followed by a secondary suppuration, will hardly allow us to term such a disease benignant. But the concrete new-

growths of connective tissue may also, by their extension in certain situations, prove dangerous to the organism, as may be seen in those which take place in the submucous tissue of the *larynx* or of the *urethra*.

The new-formations usually *participate*, both in their outward form, as well as in their internal structure, with those of the basis from which they spring. Thus we find a papillary growth of connective tissue in the *condylomata* of the skin or mucous membrane, in cutaneous warts; and in the coloured papillary *nævi*, the new-formation of vessels also shares the character of the vascular disposition in the part. Elastic filaments, which are a very frequent accompaniment of new-formations of connective tissue, occur in trifling number, and of delicate structure, or are wholly wanting in growths, the tissue of whose basis contains very delicate or very scanty elastic elements, or which may be wholly without any. Thus, in fibroid tumours of the *uterus*, we find a very close network of connective-tissue-bundles, whilst, like the substance of the *uterus*, they contain no elastic tissue. Exceptions to this rule, however, occur, and, in new-growths, elements may be seen which are foreign to the basis whence they spring. We need only refer to fibrous tumours which are subject to a true ossification in their interior, whilst in the parent-tissue there is no vestige of an osseous basis.

The *consistence* of these new-growths depends upon their structure and degree of development, conjointly. The greater the preponderance of cells, so much the softer are they, the consistence increasing in proportion to the development of the fibrous element. If the growth be merely of a gelatinous consistence, it will be found to be in the first stage of development, and to be characterised by its containing *mucin*, which is rendered apparent by the opacity produced on the addition of acetic acid, and by the appearance under the microscope of the straight filaments so often mentioned already. It is also well known, that young connective-tissue-formations, or rather such as have remained at a low stage of development, do not, like those more perfectly developed, afford the reaction of *gelatin*.

But the consistence of the pathological new-formed connective tissue, should not be taken as a ground for the general conclusion that the new-growths in which the formation of cells

predominates, are always of later date than those in which the fibrous frame-work is the principal constituent. Instances occur, to show that soft connective-tissue-tumours, with a predominant cell-formation, retain that character for a long time, never assuming a more consistent, fibrous structure. On the other hand, fibrous forms are often seen, which are developed and grow in a comparatively short time. A growth of connective tissue having attained to a certain degree of development, may remain stationary, and undergo no further change. An example of this may be seen in those desmoid tumours which persist for years together without any alteration in their external aspect, or in their size. In such cases, it may be supposed, that nutritive material is afforded in exactly the proportion required for the maintenance of the tumour in *statu quo*, as is the case in normal nutrition.

We shall now proceed to the consideration of the special relations of new-formations of connective tissue in the various organs, commencing with the simple forms, and concluding with the more complex. First, however, giving figures illustrative of some of the formations.

The embryonic forms of pathologically developed connective tissue, may be readily studied in the gelatiniform exudations of the mucous, serous, or fibrous membranes, requiring for their display, merely the snipping off with a pair of scissors of a portion of the exudation, since they lie in a transparent, structureless *stroma*. The gelatinous, viscous coating (vitreous *mucus*), so frequently found in the neck of the *uterus*, generally contains a large quantity of, usually very variously shaped, elementary structures. In many places, pus-corpuscles are deposited in groups together (fig. 76, *b*, *c*), in which, upon the addition of acetic acid, the multifid *nuclei* are manifest; whilst other smaller corpuscles (*a*) remain unchanged, presenting the aspect of nuclear structures. But there are also, scattered granular globules, having a diameter of from 0·0132

FIG. 76.

—0·0177‴, which undergo no change. These are the same corpuscles which are represented in fig. 66, as occurring in *sputa* treated with acetic acid. Occasionally, also, may be noticed, the very delicate, transparent elements, already described in the General Part, in reference to the theory of the evolution of pathological new-formed cells, and which become flattened in consequence of their mutual apposition, and assume a polygonal outline. They constitute entire chains, or are aggregated into groups. Their average diameter is from 0·053—0·066‴. In some a *nucleus* is visible, not surrounded by any granular appearance. Besides these elements, elongated cells may be remarked, which, when of a conical form, may represent the remains of the columnar *epithelium*, but when attenuated on both sides, terminating in a filamentary appendage, and sometimes presenting in the enlarged central portion, an oval *nucleus* with a *nucleolus*, are equivalent to the fusiform cells of connective tissue. Even without the addition of acetic acid, delicate, microscopic, usually rectilinear filaments (*d*, punctate streaks) will be found in the tenacious coating taken from the *cervix uteri*. The filaments in question are occasionally not unlike a plicated membrane, and represent precipitated *mucin*. These constituent elements are frequently, for the greater part, in a state of fatty degeneration of the cell-contents, or acquire from the colouring matter of the *blastema*, a yellowish, or yellowish-brown hue. The embryonic forms of connective tissue are also met with in the gelatinous exudation on the nasal mucous membrane in cases of *lupus*.

We have frequently had occasion to notice very well marked formations of immature connective tissue on the *concave surface of the placenta* in cases of abortion, in the latter months of pregnancy. In these instances, after the removal of the chorion, especially at the point of insertion of the umbilical cord, a pultaceous, yellowish substance removable with the scissors, in a thin stratum, and about 0·44‴ thick, comes into view, which is continued towards the border of the *placenta*, gradually diminishing in thickness. In this exudation will be found, scattered elementary organs, which may be arranged in two categories: 1. The *rounded*, of various dimensions, with a vesicular, light-coloured *nucleus*, and usually yellow, finely granular, or, occasionally, fatty contents (fig. 77,

the spherical corpuscles). 2. The *oblong*, or fibre-cells, which present great diversities of form. Their body, or thicker central portion, is of various dimensions, and, in general, it may be said, that the more voluminous it is, the shorter are the processes given off from it; and the longer these become the more attenuated does the body of the corpuscle appear to be rendered. In its broadest part, an oval *nucleus* is often apparent, which in our specimens was quite clear and transparent, without any trace of a *nucleolus*, and lay with its longer diameter in the longitudinal axis of the fusiform cells. The corpuscle presents different forms, according as it is furnished with 2, 3, or 4 processes. The processes diminish gradually in thickness, from their insertion towards the extremity, although this is not constant, for fusiform enlargements may be noticed in the longer processes. They frequently divide also into two branches, and these again into two twigs. When three processes are given off from the corpuscle, the latter assumes a triangular shape, a whip-like appendage being placed at each angle, and should a fourth be superadded, the corpuscle becomes, as it were, drawn out into four points. The four processes, in this case, are either diametrically opposite, so that a stellate figure is produced, or the two secondary processes are parallel to each other, so that there are two superior and two inferior processes running in the same direction. As the processes multiply, the *nucleus* divides, and, ultimately, in the body of the cells furnished with four processes (quadripolar cells), two *nuclei* may, not unfrequently, be seen. The duplication of the *nucleus* may, moreover, be noticed even prior to the formation of a third or fourth process.

Fig. 77.

These observations with respect to the fusiform cells and their transition into those with three or four processes (tripolar, quadripolar), in which a division of the *nucleus* may be observed, clearly indicates a spontaneous multiplication in this kind of cell. It is not necessary, therefore, that they should always have proceeded from the spherical elements of connective tissue, by the formation of two diametrically opposite processes.

These young elementary bodies lie scattered without any definite order, as is shown in fig. 77. It is only after repeated multiplication of the fusiform cells that entire layers are constituted of them; among which are seen, rounded, or elliptical cells with a distinct *nucleus*. In fig. 78 is shown an entire layer of fusiform cells of this kind, and, among them, rounded isolated cells with *nuclei* of various sizes. This specimen of connective tissue in a state of development was also taken from the concave surface of the *placenta* of a dead fœtus in the last month of pregnancy, and represents a further stage of development. In order to avoid the very possible confusion of the conjoined, fusiform cells with organic muscular fibres, the addition of acetic acid is sufficient, by which the respective *nuclei* are rendered more apparent; those of the former being oval, whilst in the latter tissue, they appear very much elongated, and truncated at each end.

Fig. 78.

The comparison of the mode of evolution of this pathological, new-formed connective tissue with that which is presented in the still *gelatinous connective tissue* of the embryo, will show no *essential difference*. The only distinction resides: 1. In a difference in the size of the elements, which, in the newly formed connective tissue, is more considerable. 2. In a greater multiplicity of form,—the circumstance of the deformed cells remaining at a determinate stage of development being the cause of an endless diversity of shape. 3. In an irregularity in the nutrition of the cells, evidenced by a retrograde metamorphosis of their contents. As an instance of this may be taken the fusiform cells, in fig. 77, in a state of incipient fatty degeneration, in which change even the spherical elements are also involved. This premature involution of the pathological, new-formed cells

is a fact of the highest moment, bearing the impress, as it were, of the anomalous nutrition which is an almost constant phenomenon in every new-formation. 4. The elementary organs of the pathological new-formation do not go through the same phases of development in such regular order, as under normal circumstances, the process being interrupted by the premature involution. The reason of this may reside partly in the chemical difference of the *blastema*, partly in that unknown factor to which we give the name of formative *nisus* or power of the organic *matrix*. An unequal distribution of the chemical elements may also be conceived to take place in the pathological exudation, which in one spot will afford material only for cells of one kind, whilst in another place, cells of a different kind will be produced from it, which no longer retain the normal organic character. 5. The multiplication of the cells by division is impeded by abnormal formative conditions in the latter, or by a degeneration of the cell-contents; and in consequence of this, it may, in many situations, be entirely arrested, whilst in others it proceeds with proportionately greater vigour. Thus, an inequality in the propagation of the cells is set up, evidenced by an asymmetrical form of the new-growth of connective tissue. In intimate connexion with the new-formations of connective tissue stand those of sanguiferous canals; which never occur without the former, and, consequently, may be treated of at the same time with them.

§ 1. Serous membranes.

Very extensive new-formations of connective tissue not unfrequently occur beneath the parietal lamina of the *arachnoid*, containing highly developed new vessels, and which, as is well known, may be readily raised with the forceps. In the case here represented, the formation constituted a thin, membranous, orange-yellow coating of lax consistence. Only a few blood-vessels could be perceived with the naked eye. The orange-yellow colour depended upon a large quantity of flattened, oval, or polygonal, deep-yellow and reddish-brown elements (fig. 79, *b*); the pigment granules were some of them 0·0013‴ in size, and almost filled the cell, so that only a narrow

border, formed by the remaining cell-membrane, was apparent, or the latter had wholly disappeared, the granules forming the delicately notched boundary. A *nucleus*, in the form of a

FIG. 79.

distinctly defined, lighter coloured spot was not unfrequently evident in these dark-coloured elements. The cells with less pigment (*c*) contained merely minute aggregations of pigment-molecules, by which the *nucleus* was in great part, or entirely, concealed. The rest of the contents consisted of a very fine-molecular matter. The cells without any pigment (*d*) and, at the same time, of different size, elliptical or oval, presented a granular *nucleus* (as may be seen in the *nuclei* which have escaped); the *nucleus* was comparatively larger as the size of the cell was less. Cells with two *nuclei*, or with one, in which division had commenced, and of an hour-glass shape, were occasionally to be seen. These various kinds of cells were imbedded in a *stroma* of decussating connective-tissue-bundles; and those containing an abundance of pigment were grouped especially around the newly formed vessels.

That these cells should be regarded as newly formed, admits, perhaps, of no doubt, since, in the normal condition, no organized structures of the kind, exist in the same situation, which, by any kind of degeneration, could undergo such a morphological change. A second question might arise, as to whether they are to be looked upon as young, connective-

tissue cells, or rather as newly produced epithelial cells? We shall have frequent occasion to remark, in newly formed connective tissue, the existence, not in any way on its surface, but in the midst of its substance, of flattened, epithelial-like cells, and are of opinion that no well-defined distinction can be drawn between a flattened connective-tissue cell and one of epithelial nature. *Epithelium*, indubitably of new-formation, is met with, sometimes on the surface of papillary connective-tissue-formations, sometimes as a lining on the inner surface of cysts.

Care should be taken not to confound the inorganic elements, occasionally met with in organized exudations of the kind now under consideration, with the organic; it is for this reason that the concretions, sometimes bare, sometimes contained in capsules of colloid substance, have been represented at *e e*, fig. 79. These bodies sometimes assume the appearance of finely granular, sometimes of botryoidal masses. They are characterised by their abrupt, dark contours, their tuberous surface, and occasionally distinct, concentric lamination. In the present case, they were surrounded by a clear border, which was itself, sometimes, concentrically laminated, and was unaltered by acetic acid, whilst carbonated alkalies caused its disappearance, the mineral constituents being, at the same time, rendered more distinct. These concretions, morphologically and chemically, precisely resemble those of the pineal gland, and of which, in the normal condition, the brain-sand is constituted, composed of carbonate and phosphate of lime. They occur as a mineral new-formation in organized new-growths, sometimes isolated, sometimes aggregated into groups. In older individuals they are, not unfrequently, met with in considerable quantity in the choroid plexuses, and often in the so-termed Pacchionian granulations.

The newly formed *blood-vessels* in these growths are of especial interest, and their anatomical relations and distribution may be readily observed. Those vessels which are not included in the class of the finest capillaries, are especially prone to exhibit saccular dilatations (fig. 79, *a a*), assuming the form of varicose enlargements, with an increase of the calibre of the vessel, and either bulging mostly towards one side, or situated at the points of inter-communication of the branches,

when they appear more like an expansion of the dilatations usually existing at those points. When the contents of vessels in this condition are washed out, their *simple structure* is rendered evident. For although, from their size, they might be supposed to have a more complex structure, they will be found to be constituted essentially like the capillaries, and merely to present elongated *nuclei*, disposed at determinate distances, and placed with their longer diameter parallel to the course of the vessel. Transverse *nuclei* occur more rarely, and, in new-formed vessels of this kind, we have never noticed the fully developed, longitudinal and annular coats, which are elsewhere so characteristic of vessels of the same size. They are imbedded in bundles of connective-tissue-fibres.

If the vessels be traced to their finest ramifications, a peculiar condition will be observed in many situations; resembling that which is presented in the embryonic state, attending the multiplication of the capillaries (*vid.* in the General Part, "Formation of Vessels," p. 81). An infundibuliform prolongation filled with blood will be noticed, given off from a capillary, which, running out into a filament, unites with a similar prolongation from a contiguous vessel. In other words, two slender cones, tinged with blood, will be seen with their points in apposition, and the communication between which is established by the gradual coalescence of the elementary organs of the capillaries on each side.

Observations of this kind, with respect to the mode of multiplication of the finest vessels, should be made in sufficiently thin sections, which are best prepared with a fine pair of scissors; it is better, also, to employ a solution of salt or sugar, instead of water, as a moistening medium, in order to avoid the removal of the *hematin* from the blood-corpuscles contained in the vessels, as otherwise it would be impossible to make out the cæcal *diverticula* of the capillaries.

The new-formed vessels apparently emerge from the inner surface of the *dura mater;* and are characterised by their wavy course (fig. 80). But the curves formed by them are unequal, that is to say, wide, flattened curves often alternate with short and abrupt ones. The direction taken by the vessel frequently changes suddenly; after running, for instance, in one direction in undulating curves, it is suddenly

bent at nearly a right angle, makes a few curves in the new direction, and again changes its course.

Fig. 80.

In its course, it gives off comparatively but few branches, and, consequently, diminishes only very gradually in size until it breaks up into a fine network of capillaries, which retain the same wavy character, and terminate in loops. The capillary plexuses are aggregated into coils, and are closer in proportion as the organization of the new-formation is more advanced.

If the mode of distribution of these vessels be compared with that of the vessels in normal tissues, a striking similarity between the pathological, newly formed vascular plexus, and that in the lax connective tissue (as, for instance, in the capsule of the kidneys) cannot fail to be recognized. Thus we see that the character of the new-formed connective tissue is, also, manifested in the distribution of the vessels.

With respect to the question, whether these blood-vessels arise independently in the self-organizing exudation, or should be regarded merely as lateral multiplications of the original vessels, we must refer to the new-formation of blood in pleuritic exudations.

We shall now proceed to the consideration of those new-formations of connective tissue which, under the name of *Pacchionian glands*, are well known, as existing on the upper borders of the longitudinal fissure of the *cerebrum*. Until quite recently, these bodies have been regarded as pathological products; in fact, until it was shown by Luschka[1] that they exist in the cerebral membranes in the normal condition, projecting more or less above the surface of the arachnoid, in the form of villous elongations of its tissue. On this account he has proposed for these Pacchionian glands, or granulations, the name of *arachnoidal villi*. He has also indicated a new

1 [Müller's 'Archiv,' 1852.—Ed.]

and, in a pathological respect, important seat of origin of them, that part, namely, of the *parietal lamina* of the arachnoid which extends along the course of the longitudinal sinus.

These villosities, in advanced years, and, in particular pathological conditions, perhaps also at an earlier period, increase considerably in volume, and new *villi* are superadded to the old. The minute, soft, greyish, isolated granulations which, at the time of puberty, are already perceptible to the naked eye, collect into groups which, at the borders of the longitudinal fissure, especially when the inner cerebral tunics are thickened, become more closely approximated, and constitute continuous chains. At the same time they, not unfrequently, assume a yellowish or yellowish-red colour, and a greater degree of consistence.

With respect to their more intimate structure, the basal portion, the body, and the rounded extremity, in the *hypertrophied villi*, as well as in the normal, must be considered. The former are larger in diameter, and in them the connective-tissue-bundles, radiating from the arachnoid tissue, appear closer, the mode also of their arrangement is changed; whilst, in the normal condition, the bundles run in a parallel direction, in the hypertrophied *villi* they decussate in various ways, forming a confused network. Upon the addition of acetic acid, Luschka noticed very numerous bundles, which appeared to be surrounded in an annular or spiral direction by an elastic fibre. The bodies of the *villi*, and their clavate ends, are deformed, the usual pyriform shape being thus lost.

A larger or less number of smaller *villi* are always seated upon these enlarged ones, in the form of flask-like appendages. Closer examination readily shows that the latter growths consist of embryonic connective-tissue-elements; that is, the framework of the *villus* is composed of somewhat elongated, fusiform cells, with a well-defined, oval, excentric *nucleus*. As the cells are closely approximated, and the *nuclei*, particularly after the action of acetic acid, appear very densely crowded together, it might readily, though erroneously, be conceived that the whole consisted merely of a *nuclear* layer. The shape of the young *villi* is spherical, pyriform, or conical, with all possible intermediate forms. When more elongated, they usually present several nodular enlargements. Their

longitudinal diameter varies, on the average, between 0·004—0·22‴. The basal portion is usually attenuated, although some occur sessile on a broad base.

In the morbid growth of the arachnoidal *villi* the younger forms spring up rapidly, whence arises an entire group of larger ones, which are subject to all possible variations in the mode of their relative disposition. They may be so closely packed together that the entire group, viewed from above, presents a mulberry-like aspect; or if a multitude of them are placed upon a common peduncle, and the *villi* are all of pretty uniform length, the growth assumes an umbellate appearance. If solitary *villi*, or a few together, are disposed around a long peduncle we have forms resembling bunches of grapes, &c.

The *forms of involution* to which the growing arachnoidal *villi* are subject, are of pathological importance; in advanced degrees of the new-formation an opportunity is always afforded of observing these changes. The most usual mode of involution is fatty degeneration, consisting in an accumulation of larger or smaller fat-globules, which, by their minute subdivision and distribution among the connective-tissue fibres, deprive the *villus* of some of its normal transparency; and may, in part, be regarded as the cause of the yellowish colour which is apparent to the naked eye. These fat-globules are closely crowded, particularly towards the summits of the *villi*, not unfrequently wholly concealing the connective tissue. When in a state of involution, the *villi* often appear to be pervaded by a dirty, yellowish-brown pigment. Colloid corpuscles, sometimes in the form of elliptical, clear discs, sometimes with concentric rings, and occasionally with a distinct, molecular central corpuscle, may usually be found upon careful examination of a *villus* which has been torn to pieces; they seem to be lodged in the substance itself of the *villus*, and are not changed upon the addition of acetic acid. In this situation their size does not usually exceed certain dimensions (about the volume of an epidermis cell). Their outline is usually circular, but occasionally oval, or reniform, and they are of a greyish colour. As instances of a morbid affection of the arachnoidal *villi*, especially worthy of notice, Luschka describes the deposition of earthy constituents, in the form of minute granules, disseminated among the structural elements, but this is of rare occur-

rence, as, also, is the deposition in them, of a peculiar brownish matter. No trace of blood-vessels in the morbid arachnoidal *villi* ever occurred to his observation any more than it has to ours, a further proof of what has already been, frequently, stated, that new structures in their type of formation observe that of the parent tissue whence they spring. For instance, if the normal arachnoidal *villi* contained vascular loops, like the normal cutaneous *papillæ*, we might also expect to find vessels in the pathological new-formed *villi*, in the same way as we find them in the pathological new-formed *papillæ* of the skin (*condylomata*).

The morbid changes in the *villi* of the parietal *lamina* of the arachnoid are essentially the same as in those of the visceral layer, only from their extent they acquire a special pathological importance, as is particularly noticed by Luschka in the following words: "They compress the fibrous tissue of the *dura mater* against the *cranium*, and, in course of time, cause pit-like depressions and even holes in the latter. From the pressure they exert upon the veins entering the longitudinal *sinus*, as well as by the partial obturation of the sinus itself, they suffice to produce impediments to the circulation in the vessels of the *pia mater*, and will thus, undoubtedly, often give rise to those exudative phenomena, as a product of which it has usually been erroneously conceived, that the arachnoidal *villi* themselves were to be regarded."

As a *genetic cause* of the growth of the arachnoidal *villi*, the disturbances of the circulation, which attend the natural involution of the organism in old age, might perhaps be adduced. In consequence of the impeded motion of the column of blood a modified transudation must take place, which—in our ignorance, it must be confessed, of its more precise nature—we regard as the principal cause of the increased amount of nutritive material with which the arachnoid is supplied. It should here be remarked that growths consisting of connective tissue are of very usual occurrence in advanced age—a circumstance which, in addition to the above reasons, may probably be explained by a defective formation of blood.

With respect to the mode of *preparing* the arachnoidal *villi* and similar dendritic, papillary, new-formations, it need only be remarked that a sufficient portion of the growth having been

cut off with the scissors, the villosities, which often adhere together, may best be studied in their mutual connexion, when they have been washed rapidly backwards and forwards in clean water, and then placed either in a flat watch-glass, or upon a glass plate, and spread out without tearing. The preparation should be examined either by transmitted or by direct light, by means of a tolerably powerful lens, when the position of the various parts may be better adjusted by needles, and the young *villi* at the borders of the larger ones may be extended by gentle stroking with a cataract-needle; superfluous portions being removed by a pair of fine-pointed scissors, when they interfere with the clearness and neatness of the preparation. It is self-evident, that in laying the covering glass upon the preparation, care should be taken not to disarrange the parts which have been duly placed, and also, that, from the size of the object, low magnifying powers should be employed, to examine the forms in their secondary arrangement and mutual connexions, and more powerful glasses for the study in detail, particularly of the younger *villi*.

The copious, organized layers of exudation on the *pleura*, are especially adapted for the examination of the various transitional forms of connective tissue, their complication with the spontaneous new-formation of blood, suppuration, &c. A layer, 2·21‴ thick, on the parietal *pleura* of an individual in whom, during life, *paracentesis* had been performed on account of *empyema*, presented on the inner surface, or that which was directed towards the cavity of the *thorax*, minute, level, lightish-grey, opaque patches with irregular outlines, which were caused by a purulent infiltration; they consisted, in fact, of pus-corpuscles lying amidst flocculent and streaky masses. In the less opaque spots, nucleated elements—some elliptical, some polygonal—could be perceived, lying in groups among the solidified protein-corpuscles. Other portions, taken from the inner side, presented only a molecular material among the laminated substance. Beneath the light-grey patches, striated layers came into view, containing, of organized elements, chiefly fusiform, closely approximated cells, mostly in a state of fatty degeneration. In the still deeper seated, or with respect to those just described, more external layers, minute, isolated, bloody points, and lastly, short convoluted blood-vessels to-

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In a gelatinous, pleuritic, organized exudation, bloody streaks could be perceived even by the naked eye, an appearance produced by longitudinal rows of blood-corpuscles, which were not contained in any independent walls, but lay among the layers of reticulated *fibrin*. But, together with the red, a few white blood-corpuscles were also visible; more numerous still, however, were minute, spherical, faintly granular elements, not so large as the red blood-corpuscles, which did not disappear on the addition of acetic acid, and, in fact, were then rendered more distinct by the increased transparency of the fibrinous substance. The same acid also rendered visible, elongated *nuclei* disposed in neat, aggregate groups. It is obvious, therefore, that in this case, a *new-formation of red and white blood-corpuscles had taken place prior to the complete development of the connective-tissue-cells*, it being otherwise established, that the aggregated deposits of spherical and elongated *nuclei* are to be regarded as a developmental form of connective tissue.

The following case will serve as a striking instance of the spontaneous, new-formation of blood. A tough, coriaceous, yellowish coating, in many places about 2·65‴ thick, on the visceral layer of the pleura, could be raised from the surface of the compressed lung, with which it was connected by a reticular tissue. A section perpendicular to the surface of this false membrane, disclosed a space marked by bloody points (fig. 81, *a*) of considerable extent, and which was enclosed on both aspects by yellowish layers. The quadrangular piece was divided into halves by a section parallel to the surfaces, when the cut surface (*d d*), and the corresponding surface in the other half (*c*) presented the following conditions: The spots indicated by the dark lines in the figure were

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In a compact, almost cartilaginous, coating on the pulmonary *pleura*, in the midst of the solid substance, were found irregular, occasionally wavy, bloody streaks and spots. The *matrix*, which, in transverse sections, was transparent, presented a laminated appearance, arising from superimposed layers containing isolated, rounded elements 0·0061—0·0079‴ in diameter, enclosing an excentric, vesicular *nucleus* surrounded by a dirty-yellowish, granular substance. In the less transparent, greyish-yellow portions, collections of minute fat-globules and granule-masses were accumulated.

Closer examination of the blood in the newly formed condition, shows that the corpuscles differ more in size among themselves than is the case under other circumstances. For numerous minute blood-corpuscles, 0·0017—0·0022‴ in diameter, are presented, exhibiting as yet no central depression, of a more spherical shape, and of a modified red colour.

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latter tissue is too little advanced for the production of blood-vessels, which in general is only observed to take place when the formation of connective tissue has proceeded beyond the first, embryonic forms, and where the fusiform cells—the fundamental element for the development of blood-vessels—have assumed a greater degree of importance. This formation of blood in the shape of spots with irregular prolongations, streaks, and points, recalls the type so frequently met with in medullary *cancer*, as will be more particularly noticed in the proper place.

It is well known, that after pleuritic exudations, new formations of lax connective tissue not unfrequently occur, in which a considerable number of new vessels are visible. Fig. 82 represents a vascular plexus of this kind on the visceral *pleura*, and which was readily removable by the scissors. These vessels, like those represented in fig. 80, are also characterised by their irregularly serpentine course. The larger vessels make numerous zig-zag curves, which are alternately wider and narrower; the smaller vessels retain the same characters in their convolutions, and terminate in a loop. Thus, upon the whole, it will be seen that the type of this vascular arrangement resembles that presented in the lax connective tissue.

FIG. 82.

The pulmonary *pleura*, as is well known, frequently exhibits granulations of the size of a pin's head down to that of a just perceptible nodule. These are formations of connective tissue precisely similar to those described as occurring on the arachnoid. In the instance here represented, they were rounded, of a black colour, sometimes isolated, sometimes assembled in groups of from ten to twenty together, and of a loose texture; they could be removed by means of a cataract-needle. The

laxity of their texture seemed to depend upon the considerable amount of black pigment-cells, whose form approximated the polygonal, and which usually exhibited a light-coloured spot corresponding to the *nucleus* (fig. 83, *a*). Young connective-tissue-elements were met with in less number, composed of round and fusiform cells, which, from their minute size, might be readily overlooked, and possessed a comparatively large, light-coloured *nucleus*, which, in the fusiform cells, contained a projecting *nucleolus*. These elementary bodies (*a*, *b*) were enclosed by decussating, fibrous bundles (*c c*), of which the *matrix* was composed, and probably belonging, in great part, to the separated fibres of the pleural tissue. Numerous aggregations of blood-corpuscles were also lodged in the granulations, as at *d*, together with an abundance of free pigment, in the form of amorphous, black corpuscles, especially towards the periphery of the granulation.

Fig. 83.

Dendritic *papillary new-formations of connective tissue* also occur on the *pleura*, which have been more particularly described by R. Heschl. He has found them especially at the lower border of the inferior lobes of both lungs, and, in a few cases, extending a short distance on the outer surface of the parts in question; and describes them as sessile growths, about half an inch long, and consisting of an axis of greater or less thickness (up to half a line), with the free end flattened and clavate, around which were seated numerous similarly shaped projections, some smaller some larger than the main, central stem.

He frequently noticed that both the former and the latter of these processes were subdivided at the apex into several smaller ones. These growths are stated by him to be invested with a tesselated *epithelium*, and to contain numerous fine vessels. In other respects their structure does not differ from that of the arachnoidal *villi*. In one instance Heschl noticed excrescences consisting (with the exception of the peripheral layers of connective-tissue-elements) of normal adipose tissue. These growths were also branched in a similar way to the

above, and presented the usual aspect of synovial excrescences composed of adipose tissue—they constituted, in fact, a *lipoma arborescens*.

The growths on the *pericardium* known under the names of *granulations* and *vegetations*, also contain young connective-tissue-elements. Papillary new-formations, containing fat-cells in their interior, are more rare.

The new-growths of connective tissue of a dendritic form, not unfrequently met with on the *synovial membranes*, and which, in a pathological respect, are of the utmost importance, originate, without doubt, in the synovial processes always existing in the normal condition, and which were first subjected to a minute anatomical investigation by Kölliker. These processes are mostly situated in the groove-like depression of the synovial membrane where it is inserted into the border of the articular cartilage. They consist of a central bundle of connective tissue usually enclosing one or several cartilage-cells, and of a dense layer of *epithelium*. In shape they present endless diversity, and the basal portion is either an elongated peduncle or a shorter and thicker stem; they are placed either isolated or in several groups together; and when shorter and more voluminous contain fat-cells or convoluted vessels. In pathological conditions these processes increase in the same way as the arachnoidal *villi*, and become developed into the forms described by Rokitansky under the name of "dendritic vegetations on the synovial membranes."

The *pathological forms* of the processes, though presenting, both in their outline and in their structure, much in common with the normal ones, still afford some peculiarities: 1. Several lateral branches are given off from one stem, and from these, lateral twigs, so as when unfolded to exhibit an arborescent ramification of bands of connective tissue, projecting into the cavity of the joint with sometimes rounded, sometimes clavate or conical extremities. Denser groups of closely contiguous processes are also formed, as is the case in the normal condition. The processes thus placed in close apposition become mutually flattened and disposed in foliate plates one upon the other, or may be grouped into mulberry-like structures. Those which project further into the joint, frequently support, on a long, slender peduncle,

elliptical or oval, consistent, little heads,—a shape, moreover, which is occasionally met with in joints in the normal condition. Rokitansky has also noticed that the vegetations grow particularly close together in the neighbourhood of the insertion of the fibrous articular capsule into the parietal or, as it were, reflected portion of the synovial membrane, and that without doubt this circumstance explains how it is, that in that situation, instead of contiguous, isolated vegetations, a trabecular formation is often observed. In this case I have no doubt that the vegetations, transformed into bands of connective tissue, have grown together.

2. With respect to their elementary structure, it must be remarked that in the pathological forms of these growths the fibres of connective tissue are very distinct, and that an epithelial covering is wanting, at any rate, in most cases. The fibres of connective tissue usually run in fine, wavy curves, parallel to the long axis of the process, as far as to its rounded extremity, where they arch round, assuming, not unfrequently, at the same time a rectilinear course. Smaller growths also are commonly met with, in which the formation of coiled, connective-tissue-bundles has not been attained to, but in which the fusiform cells are arranged in apposition, in symmetrical order, exhibiting their oblong *nuclei*, after the addition of acetic acid, at uniform distances apart, and placed in an obliquely ascending position. The very minute, hyaline, terminal branches often hardly 0·0088‴ thick, present no distinct elementary structure whatever, it appearing, consequently, as if the protein-compounds in the semi-solid condition, assemble in a dendritic form, as is so frequently the case in crystallization, where the process goes on under the eyes of the observer. The cartilage-cells, which, as has just been remarked, are normally present in the synovial processes, occur in greater numbers in many of the new-formed growths, being deposited in entire series or groups in the interior of the process. In these also, the cartilage-cell in several pathological states, undergoes a physiological metamorphosis; that is, after a previous thickening of its wall it becomes a bone-corpuscle, a metamorphosis which never takes place in the cartilage-cells in the synovial processes in the physiological condition, unless perhaps in old age.

These dendritic new-formations of connective tissue, ultimately undergo the various kinds of metamorphosis which attend the involution of all new-growths; the rounded, free extremities in particular becoming the seat of fatty degeneration, in which the cartilage-cells also participate. By the absorption of yellowish- or reddish-brown, colouring matter, the terminal portions of the vegetation assume a corresponding dark hue.

3. The *plicæ adiposæ* of the normal synovial membrane, which were at one time regarded by Havers as glands, frequently assume the dendritic form, and, more or less filling the cavity of the joint, constitute what has been described by Joh. Müller as *lipoma arborescens*.

4. The processes containing a vascular loop (*plicæ vasculosæ*) are also multiplied and hypertrophied in the pathological condition, for, according to Rokitansky, the dendritic vegetations on synovial membranes all become vascular, and consequently reddened; considerable-sized vessels running upwards and downwards in wide arches in the primitive stems, as well as in the secondary branches and twigs.

In the *bursæ mucosæ*, also, as has been more precisely shown by Kölliker, vascular and non-vascular processes occur, the latter of which possess a structure analogous to that of the processes situated at the line of insertion of the synovial capsule. In morbid conditions, as is well known, these *bursæ* enlarge considerably, and, occasionally, a process of growth is set up in the processes. We had an opportunity of submitting a case of this kind, in which the *bursa* on the patella was thus affected, to a minute examination. The swelling, which was situated above the *patella*, was about the size of a small apple, moveable, and afforded a rubbing sound. An incision into the tumour, after extirpation, disclosed a cavity filled with a yellowish fluid, in which numerous, minute, pale, flattened and smooth corpuscles were floating about; these bodies were, some of them elliptical, some oval, and they had a mean diameter of 0·88—1·32‴. The inner surface of the cavity was uneven, in parts, presenting filamentous *trabeculæ*, or beset with villous, sessile and clavate growths, which constituted, in some parts, a continuous chain of elliptical corpuscles, united by a delicate tissue, and, when detached, manifestly representing the isomorphous, free particles seen floating in the fluid.

The elements of these processes proved to be identical with those of young connective tissue. The most recent formations could best be observed in the tissue uniting the connected groups; they were accumulations of pale, rounded corpuscles, not unlike pus-corpuscles; in many of them, however, an oval or still more elongated *nucleus* could be distinguished, which was rendered more apparent on the addition of acetic acid, and consequently all suspicion of their being pus-corpuscles was obviated. These youngest forms were also present in the central portion of the elliptical corpuscles, surrounded by minute fusiform cells; their relative position and arrangement were most distinctly perceived, when the corpuscles in question were treated with acetic acid. Their aspect presented some resemblance to the *acinus* of a gland; for the delicate connective-tissue-fibres formed arches, and enclosed the embryonic, minute elements. In the denser and larger *villi*, the connective-tissue-bundles were more abundant. Of elastic, convoluted filaments, not a trace could be perceived, even after the addition of carbonate of potass.

The *plasma*, which is deposited in large quantity in morbid conditions of the synovial membranes in general, is not, however, always organized into perfect connective tissue, but, especially in the *bursæ mucosæ*, frequently remains at a lower stage of organization, or the new-cell formations may even be destroyed by the effusion of fluid plasma. Thus, in very much distended *bursæ mucosæ*, we observe chiefly, shrunken *nuclei*, imbedded in a fine-molecular material, and, relatively speaking, but few minute corpuscles, exhibiting a nucleiform structure.

We now approach the account of the new-formations of connective tissue occurring on the *peritoneum*, many of which present a complex structure. They occur, sometimes in a papillary, sometimes in a dendritic form, most generally on the peritoneal coat of the liver, intestines, and ovaries. On the concave surface especially, of the right lobe of the liver, are seen formations, sometimes in the form of shortly pedunculated, flattened discs, about the size of a pin's head or more. They are of a greyish-yellow colour, compressible, and usually more or less transparent. Their intimate structure is limited to connective-tissue-bundles, which constitute the outer investment of the papillary new-formation, and to immature, minute

connective-tissue-cells (short-fusiform, and rounded, nucleated-cells), which are enclosed by the arching connective-tissue-fibres curving round the truncated extremity of the growth. But many of these papillary formations have no organized contents, nothing being apparent in them but a fine-molecular substance, surrounded by a coat of connective tissue. Whether the latter is always invested with epithelial cells, may be doubted; but in many cases, flattened, polygonal, appressed, epithelial cells could be perceived. The second modification presented by these new-formations of connective tissue, both on the peritoneal coat of the liver, as well as on that of the intestines, is seen in the filamentous forms, which branch in a dendritic manner, and more rarely terminate in a flattened, clavate, well-defined extremity. New-formed blood-vessels may occasionally be traced for a short distance from the base of these filamentous vegetations.

The papillary new-formations of connective tissue, frequently arborescent, or of a conical form, and with or without a peduncle, seated upon the peritoneal covering of the ovary and broad ligament of the *uterus*, are of especial anatomical interest. For in numerous examinations, *all intermediate stages, from the papillary new-formation, up to pedunculated cysts,* will be met with in this situation, so that it is quite clear that the latter here arise from the accumulation of a serous fluid in the rounded, terminal portion of the *villus*-like new-growth.

Another important circumstance is also observed, which appears to be the cause of the consecutive secretion of a serous fluid, and of the subsequent production of epithelial cells on the inner surface of the cavity containing it; this circumstance is the direct *new-formation* of vessels in the sometimes sessile, sometimes pedunculated, papillary new-growths. In fig. 84, we see the distribution of the vessels on the sur-

FIG 84.

face of an oval cyst, formed by the metamorphosis of a new-growth of connective tissue (*a*), which rose with a wide base from the surface of the broad ligament of the *uterus* (*b*). A large, arched, venous trunk ran over the surface of the cyst in the way depicted in the figure, formed by the confluence of comparatively slender vessels, and rapidly enlarging in diameter. The most delicate vessels, of capillary dimensions, have a much convoluted course, and unite, here and there, to form a tolerably close *plexus*, with arched loops,—a mode of distribution proper to connective tissue. The capillaries are supplied by an arterial branch, which, in the instance figured, descended along the recurrent vein towards the cyst. The vessels of the latter were imbedded in a layer composed of bundles of connective tissue, crossing each other at different angles, and constituting a very close network. The inner surface of these minute cysts is by no means smooth throughout, but divided by projecting ridges into several compartments, which are more apparent in the larger cysts. The inner lining, even of the very minute cysts, scarcely 0·132‴ in diameter, is constituted of a single layer of delicate, polygonal epithelial cells.

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The elementary examination of the inner surface of a pedunculated cyst, of the size of a lentil, dependent from the peritoneal surface of the ovary, showed the following particulars: the innermost lining of the cavity, which was occupied by a clear, yellowish, thin fluid, was constituted of a layer

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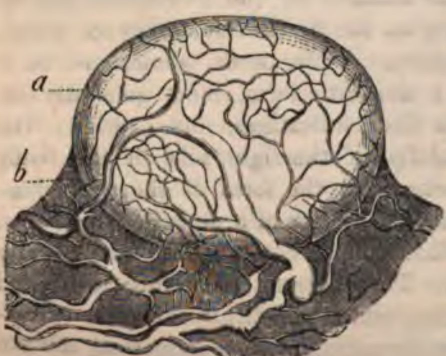
Another important circumstance is also observed, which appears to be the cause of the consecutive secretion of a serous fluid, and of the subsequent production of epithelial cells on the inner surface of the cavity containing it; this circumstance is the direct *new-formation* of vessels in the sometimes sessile, sometimes pedunculated, papillary new-growths. In fig. 84, we see the distribution of the vessels on the sur-

FIG 84.



face of an oval cyst, formed by the metamorphosis of a new-growth of connective tissue (*a*), which rose with a wide base from the surface of the broad ligament of the *uterus* (*b*). A large, arched, venous trunk ran over the surface of the cyst in the way depicted in the figure, formed by the confluence of comparatively slender vessels, and rapidly enlarging in diameter. The most delicate vessels, of capillary dimensions, have a much convoluted course, and unite, here and there, to form a tolerably close *plexus*, with arched loops,—a mode of distribution proper to connective tissue. The capillaries are supplied by an arterial branch, which, in the instance figured, descended along the recurrent vein towards the cyst. The vessels of the latter were imbedded in a layer composed of bundles of connective tissue, crossing each other at different angles, and constituting a very close network. The inner surface of these minute cysts is by no means smooth throughout, but divided by projecting ridges into several compartments, which are more apparent in the larger cysts. The inner lining, even of the very minute cysts, scarcely 0·132''' in diameter, is constituted of a single layer of delicate, polygonal epithelial cells.

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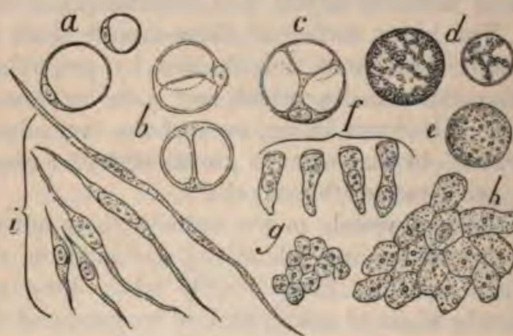
The elementary examination of the inner surface of a pedunculated cyst, of the size of a lentil, dependent from the peritoneal surface of the ovary, showed the following particulars: the innermost lining of the cavity, which was occupied by a clear, yellowish, thin fluid, was constituted of a layer

of epithelial cells, of various sizes and conformation, in different parts of the cyst. On the one hand, for instance, there were fully developed columnar epithelial cells (fig. 85, *f*), which, viewed on the side, presented a broader, as it were, truncated extremity with a double contour line, which was directed towards the free surface, the other end being attenuated, and turned towards the exterior. Their shape was cylindrical, conical, or indented, and they contained a *nucleus,* usually of an oval form, with a *nucleolus.* The contents of the cells consisted of a fine-molecular substance. When these cells were viewed with their long axis directed towards the observer, and on the free surface, they presented

Fig. 85.



a polygonal form, owing to their mutual pressure (*g*), and when the *focus* was carried a little deeper, a distinct molecule was visible nearly in the centre of each—the *nucleolus.* Thus, they corresponded in all respects with the columnar *epithelium* of the intestines. On the other hand, flattened, polygonal elements occurred (*h*), sometimes with a rounded or oval *nucleus,* and frequently containing several fatty molecules, which, in many parts of this *epithelium,* were accumulated to such an extent as to occupy almost the entire cell. A fatty degeneration of the tesselated *epithelium* on the inner wall of the cyst, is of very frequent occurrence. Separate patches of the *epithelium* become detached very soon after death, in consequence of maceration, and probably also during life, and are met with suspended in the fluid of the cyst; they may,

also, be readily collected in large quantity from the greyish sediment precipitated from the fluid. It may be doubted whether the *epithelium* line the whole of the inner surface of the cyst, or whether it may not be absent on the projecting ridges, as observations made in the larger kind of cysts would seem to indicate. After the removal of the *epithelium*, and perhaps, also, together with it, various kinds of elements, were met with, which remained adherent to the blade of the scalpel when the surface was gently scraped. These were, in the first place, spherical cells, with an external membrane (*a*), in which at one spot an oval *nucleus*, with *nucleolus*, was lodged. The cell-contents were perfectly hyaline, without any admixture of molecules, and appeared to be surrounded by a proper membrane. These would seem, therefore, to represent either two cells contained one within the other, of which the inner and non-nucleated was closely embraced by the external nucleated cell, or an encysted portion of contents, closely surrounded by a proper cell-membrane. The portion of contents in the cells marked *b*, was seen to be divided into two parts, two closed cavities having been formed by a gradual constriction; the *nucleus*, when visible, retained its pristine position. Even when the contents were divided into three portions, as in the cell *c*, the *nucleus* remained in the original, solitary position. The degenerated forms (*d*, *e*) we regard as derived from the preceding, and cannot avoid remarking upon the similarity exhibited by them,—as, for instance, at *e*,—with the granular, non-nucleated globules occurring in pneumonic effusions.

In considering the import of *a*, *b*, *c*, several possibilities must be taken into account, whether they are to be viewed as embryonic cell-formations, or, with Rokitansky, are to be regarded as the elementary organs of the cysts; and, in fact, whether *a* is to be regarded as equivalent to a primary cyst, containing a single, secondary cyst, *b* one with two, and *c* one with three, and thus whether they are to be considered as representing an endogenous cyst-formation? It may be taken as an ascertained fact, that both in vegetable and animal organisms, a multiplication of cells, by endogenous formation, takes place, that is, new cells are formed in the interior, and appear to be surrounded by the membrane of the parent-cell.

The circumstances, however, under which this process of multiplication goes on, have not yet been fully ascertained. The question, for instance, may be asked, what becomes of the *nucleus* of the parent cell in this endogenous formation? whether it take no part in the division of the contents, as appears to be the case in the present instance, or in what cases it does participate in the division? Leaving these doubtful points undecided, this much is certain, that in accordance with histological terminology, the forms *a*, *b*, *c*, must be denominated parent-cells, enclosing one, two, and three secondary cells. Rokitansky also regards them as endogenous formations, but as connected with the development of the cysts, whose elementary rudiments they represent. But such a relation seems by no means to be proved; and we therefore think it impossible to assign such an import to these cells, retaining the more obvious opinion that they are connected, as endogenous cell-formations, either with the development of the *epithelium*, or of the connective-tissue-cells.

In proceeding to investigate the cyst-wall more towards the exterior, we always find fusiform cells of very various lengths and form (fig. 85, *i*); they are often placed in whole groups together, especially on the lax, elevated ridges, very distinctly representing embryonic forms of connective tissue. They exist in all cysts, and, consequently, a *new-formation of connective tissue* may be asserted to *exist in every cyst-wall.*

The *contents* of these peritoneal cysts vary considerably, even in outward appearance. The enclosed fluid is thin and clear, or viscid and clouded, or, perhaps even, towards the walls, of pultaceous consistence. The morphological, organic constituents may be reduced to two principal groups. 1. The unorganized elements, under which we reckon: (*a*) a fine-molecular coloured substance, forming thicker layers, and which presents precisely the same properties as the albumen precipitated from the fluid of the cyst by heat or nitric acid; (*b*) hyaline, amorphous, flattened, occasionally fissured masses, which are not further changed by acetic acid, and may be regarded as of a colloid nature; they are occasionally of a light- or dark-brown colour, and more rarely exhibit an indication of concentric lamination; (*c*) olein, in the form of larger or smaller, sometimes solitary, sometimes

aggregated, fatty molecules, isomorphous with Gluge's compound inflammation-globules; (*d*) *mucin*, in the usual form of straight filaments, which appear in abundance in the viscous fluid contents, especially upon the addition of acetic acid. 2. The organized elements may be arranged in the following series, according to the degree of their completeness: (*a*) epithelial cells, which, as has been stated above, are very readily detached; (*b*) fusiform cells, which are, probably, readily detached from the ridge-like projections; (*c*) *nuclei*, sometimes of a rounded or oval form, with a *nucleolus*; occasionally, shrunken and angular; (*d*) parent cells, with secondary cells, are of rare occurrence in the contents, being replaced by a proportionately larger quantity of (*e*) those conical, finely granular corpuscles, in which an enveloping membrane may indeed be perceived, but no *nucleus*, and whose contents are not unfrequently in a state of fatty degeneration. They may be regarded either as parent-cells in a state of involution, or as cells primarily without a *nucleus* (*vid.* fig. 85, *d*, *e*). In the pultaceous coating on the inner wall of the cyst, the young connective-tissue-formation may be perceived in certain spots, in the form of isolated, sometimes round, sometimes fusiform cells, from the latter of which, elongated, wavy fibres of connective tissue are given off.

The hydrochlorates and sulphates in solution in the fluid may be exhibited morphologically when a drop is allowed to dry. The residuum on the glass crystallizes in an arborescent form.

When a considerable number of papillary new-growths are seated on the peritoneal coat of the ovary so as to be in mutual contact, and some among them are gradually transformed into cysts, *an involution* of some of the cysts invariably takes place. Their contents become thicker, of a brownish-yellow colour, or, ultimately, even undergo cretification. In the former case we find dense, frequently brownish-yellow, colloid masses, together with epithelial and immature connective-tissue-cells, shrunken, or, perhaps, in a state of pigmented or fatty degeneration. The blood-vessels of the cyst-wall are empty, and in its parenchyma are deposited, fatty or pigment-molecules, which deprive the wall of its previous transparency. When cretification takes place, the amorphous, calcareous salts (carbonate and

phosphate of lime) accumulate in the cavity, and form, together with the fat with which *cholesterin* plates are often intermixed and the remaining organic elements, a concretion enclosed in an envelope of connective tissue.

§ 2. External integument.

New-growths of connective tissue occur very frequently in the *external integument*, and are always limited to distinct portions of the *papillary stratum* of the true *corium*, or of the tunic of the sebaceous follicles, &c. We shall commence with the description of the very frequent new-growths of this tissue which take place in the *papillæ*, and which are well known under the name of acuminated *condylomata*, and have been termed by Krämer, very appropriately, *papillomata*. They are, in fact, papillary new-formations, each of which also contains a newly formed vascular loop.

In the investigation of a *papilloma*, it is requisite to proceed to the examination of the elementary organs in the various *strata*, successively. G. Simon, to whom we are indebted for the first accurate exposition of the structure of the so-termed *condylomata*, directs that the growth should be macerated for a short time in water, and thin sections then taken from it. The first thing thus brought in view are *epidermis-cells* belonging to the horny layer, in the form of the well-known flattened elements, swelling up on the addition of carbonate of potass; and which, particularly in the deeper parts of the *condyloma*, are superimposed one upon another to a considerable thickness. A little more deeply a smaller kind of cells will be perceived belonging to the mucous layer of the *epidermis*; in these cells the *nucleus* is more distinctly seen than in the former. Lastly, if, after the removal of the *epidermis*, a little piece be taken with a pair of pointed forceps or scissors, and carefully torn to pieces, the minute, young connective-tissue-elements will be liberated. As these are very pale and delicate, it is often advantageous to colour them with a dilute solution of bichromate of potass.[1] The elliptical and short fusiform cells, with proportionately large oval *nuclei*, will be found floating in considerable abundance at the edge of the preparation. The fibres of connective tissue,

[1] [Or of Iodine.—Ed.]

towards the summits of these *condylomata*, are extremely delicate; but towards the base they become more abundant and firmer.

This mode of examination, however, is not sufficient; and for the more complete understanding of the structure, transverse sections must be made. This can be done by means of a pair of fine, straight scissors, or of the double-bladed knife, in recent, moist *papillomata*, or with a scalpel, in growths which have been boiled either in acetic acid or in plain water, and then dried; and the sections should be made in various directions (perpendicular and transverse to the longitudinal axis of the *papilloma*).

The examination, conducted in this way, affords the following results, as regards the relations of the different parts. In the axis of a straight *papilla* there is always a vascular loop (fig. 86, *a*), consisting of an ascending and descending branch. Both vessels take a wavy course, and are disposed, not merely as regards their length, but also with respect to the curve described by them, according to the form of the *papilla*. It is intelligible, that in the various positions of the divided *papillæ*, the vascular loops will also exhibit various shapes; thus both vessels are sometimes almost completely hidden, often partially so, or merely the summit of the curve may be wanting, or its lower portion. The body of the *papilla* surrounds the vascular loop, which ascends to a considerable height into the rounded end, and it consists of a bundle of very delicate connective-tissue-fibres, occupying the axis of the *papilla*, and exhibiting, after the action of acetic acid, several oblong *nuclei*. The younger connective-tissue-elements are found nearer the periphery of the *papilla*, that is, the larger with more rounded *nuclei*. The margin of the *papilla* is indicated by a double contour line (*b b*). Thus, in the centre we find the older connective-tissue-formation serving, as it were, for a solid support, and the younger production at the

Fig. 86.

periphery. In very young papillary new-formations which are seated, as apparent projections, upon the older, this elementary difference in the body of the *papilla* is not seen; occasionally nothing being perceptible but a fine-molecular substance, with a few scattered *nuclei*.

The epithelial (or epidermic) layer surrounding the *papilla*, may be regarded as double; a deeper, usually constituted of a few series of cells placed vertically with respect to the curve of the *papilla* (*vid.* fig. 86, *b*, *c*, both sides), and an outer, composed of precisely similar, though transversely disposed cells (the layer from *c c*, outwards). The oval *nuclei* of the former layer of cells are arranged with their longer diameter perpendicular to the curved surface of the *papilla*, whilst the corresponding *nuclei* of the second layer assume a more transverse direction. The *nuclei* are indistinctly granular, but we never remember to have seen them containing pigment. The transversely placed cells increase in size, up to a certain extent, towards the periphery, at the same time becoming more flattened, and occasionally presenting two *nuclei*.

The *papillæ*, consequently, must be regarded as the rounded ends of the new-growths of connective tissue, and, by their inter-connexion, as constituting the basis of the *papilloma*. It is well known that the latter consists of projections, which may be seen, even by the naked eye, to terminate, sometimes in acute points, sometimes in truncated, clavate extremities, and to be supported occasionally on a slender neck, or on a broader basis; whilst sometimes a few, grouped together, rise on a common stalk, or crowded more closely, constitute a group, separated by lateral furrows, which, when viewed from above by the naked eye, exhibits a cauliflower appearance. Now, if one of these little projections be examined in its base of connective tissue, it will be readily seen to consist of a collection of papillary new-formations, surrounded by a common epithelial (epidermic) coat. For this purpose, the free extremity of one of the conical prominences must be cut off, and when it is of some thickness a slice should be taken from both sides ' means of a straight pair of scissors, so that a vertical section e conical process is obtained. Under these circumstances, vessels be properly injected, the variously convoluted, loops may be perceived; which will occasionally be

rendered more distinct by the addition of a dilute solution of carbonate of soda. The outlines of the *papillæ* will not be clearly seen before the removal of the epidermic layer which is loosened by the same salt.

In fig. 87 we have represented the clavate extremity of one of the conical processes of a *papilloma* prepared in the above way. The growth consists of an aggregation of *papillæ,* whose rounded extremities project in all parts. In the present case these are of some width, and frequently exhibit excavations, indicating the position of lateral *papillæ,* whence its outline presents a very great diversity of aspect. Corresponding to the outlines of each *papilla* are the curves of the vascular loop contained within it. For instance, in all the lateral, more or less developed *papillæ,* the vessels run inwards, whence result the loops convoluted like the intestines, which have been described and figured by Krämer. The *papillæ* are placed in very numerous groups (twenty, forty, or more, together), not only on the rounded extremity of the cone, but also on its sides. The common base of each papillary group is constituted of connective tissue, consisting of thickened, fibrous bundles, in company with which the larger vessels run, ramifying in the same way as do the subdividing bundles. In the latter, when they have reached a certain thickness and consistence at the base of the cone, and after they have been treated with carbonate of soda or potass, a fine elastic network may be perceived. Primitive nerve-tubes undoubtedly exist in the divided base of the *papilloma* itself, but we have never succeeded in tracing them into the cones, nor, by any means, into the *papillæ.*

Fig. 87.

The papillary groups, constituting each conical eminence, are surrounded by a common epidermic coat, whose outer boundary line (fig. 87) presents only shallow depressions exactly as may be

observed in transverse sections of the skin. The epidermic layer varies very considerably in thickness, and it may, in general, be said that the brush-like acuminated cones are furnished more abundantly with protective layers of *epidermis*, especially on their ends, and are consequently less transparent than those with dilated clavate extremities, which are seated on short necks, in several groups together; on whose surface the aggregate *papillæ*, filled with blood, appear through the thin *epidermis*, like red points.

The *voluminous condylomata*, seated on a broad basis, and which are occasionally taken for epithelial *cancer*, do not differ essentially in their structure from the foregoing. The papillary new-formation in these growths proceeds with unusual rapidity, and, occasionally, isolated *papillæ* are seen completely filled with blood; forms of the latter, also, are frequently met with in a state of involution, in which brownish-yellow pigment-granules are deposited in the body of the *papilla*, sometimes in small scattered groups, sometimes more abundantly, the vascular loop ultimately disappearing. In this way entire groups of *papillæ* become atrophied. In the denser, basal portion consisting of connective tissue, in rapidly growing *condylomata*, a new-formation of blood-cells appears to take place in the *areolæ* and areolar passages; in many cases even, no independent walls can be perceived enclosing the blood-corpuscles. In other situations, again, distinctly bounded, sometimes solitary, sometimes aggregated *blood-sacs* may be perceived, that is, blood closely surrounded by a delicate wall of connective tissue, or else hollow, spherical or oval pouches of connective tissue, connected by cords, also hollow, and filled with new-formed blood. In places of this kind, where, as it would seem, blood exists in the *areolæ* of the connective tissue, either free or enclosed in a well-defined capsule, from which several processes are sent out, blood-vessels traceable to any distance, are never observed.

The investigation of the cut surface of a *voluminous condyloma*, which was removed at the base, showed that the denser *stratum* of connective tissue (fig. 88, the central faintly shaded part) is continued, in a conical form, into the lobules, splitting at the same time into numerous bifurcations. Towards the periphery of the lobules, the bands of connective tissue become weaker, and give off, at acute angles, delicate lateral

branches. In this case, blood-vessels could also be perceived running in the same direction as the bands of connective tissue and pursuing a straight or slightly wavy course to the surface of the lobules. For the better display of the denser connective-tissue-layer, the *condyloma* in question was placed in a solution of corrosive sublimate and common salt (Goadley's fluid), and a section made of it, after it had become somewhat corrugated. This corrugation took place especially in the young, embryonic connective tissue, whilst the older, fibrous tissue, which was less affected, was rendered apparent by its greyish colour; and in it, by direct light, white, young connective tissue could be perceived. We have met with the same structure in several other voluminous *papillomata*.

Fig. 88.

From a consideration of the above facts, we are obliged to adopt the opinion propounded by G. Simon, viz., that the acuminated *condylomata* are new formations constituted of connective tissue beneath a thin cuticle, composed of flattened cells; the connective tissue occurring in various stages of development, and being pervaded by blood-vessels. But we have shown that arborescent bundles of connective tissue proceed from the base of the *condyloma*, and that a mass of papillary new-formations is seated upon its peripheral extremity, and are therefore compelled to arrange the acuminated *condylomata* with the growths, termed by Rokitansky "dendritic vegetations," in which the clavate extremities are apparent in very great numbers. Bärensprung also, had previously expressed the opinion that this form of *condyloma* is a much-branched arborescent structure. As an essential attribute of this new-formation, must be reckoned the circumstance that a vascular loop is developed in each new-formed *papilla*, which is constituted exactly after the type of the vascular loops in the *papillæ* of the *corium*.

With respect to the *development* of the acuminated *condyloma*, we know nothing decisive; but this much is certain, that the surface of the *corium* must be regarded as the primary site of development, and that it is there, that the papillary new-

formation of connective tissue arises. It would seem probable that new *papillæ* are developed upon the primary, in consequence of an increased local transudation; but since we have ascertained that the structure of *condylomata* on those parts of the skin which present no true *papillæ*, and merely slight elevations and depressions, and on analogous parts of the oral mucous membrane, are precisely identical, we are not justified in assuming that the *papillæ* of the *corium* constitute the invariable point of origin of the acuminate *condyloma*. Krämer supposes that the formation of the *papilloma* depends upon an *ectasis* of the original vascular loops of the cutaneous *papillæ*, and a consequent, simultaneous, increased production of *epithelium*. The *ectasis*, again, is said to arise, either from an increased pressure of blood in the vascular loops, consequent upon an active or passive congestion; or to be induced by a diminution of the normal resistance of the walls of the vessels and surrounding tissues, especially owing to inflammations, or, lastly, by both causes combined.

According to this theory, therefore, the vessels in the acuminate *condyloma* are not of new-formation, but merely pushed out, as it were; an assumption which is scarcely tenable, if only the multitude of vascular loops existing in the *papillæ* be considered; for even in the smaller *condylomata*, about the size perhaps of a mulberry, thousands of such vascular loops may be perceived, to account for which, the original number of capillaries in the surface of the *cutis* would certainly be insufficient. Vascular loops occur, also, in the dendritic vegetations of Rokitansky, in which certainly no pushing out could be conceived to take place. The same thing occurs in the often very vascular new-formations on the surface of mucous membranes (the so-termed *polypi*), &c. We are, consequently, of opinion, that, in the one case, the original blood-vessels multiply by the formation of new branches, which enter the papillary new-formations; whilst in other cases, as in voluminous *condylomata*, the blood-vessels are spontaneously developed, and therefore independently of the original vessels, from the blood-sacs above described. For the blood may be formed independently in the *areolæ* of the connective tissue, not enclosed by any proper walls; or its formation may be preceded by the development of cæcal cavities, from which several hollow pro-

longations are sent out; but it is also conceivable that the formation of blood and that of the membrane enclosing it may proceed simultaneously.

The *multiplication* of the papillary new-formations or the growth of the acuminate *condyloma,* is more readily intelligible. It takes place, without doubt, in the same way, as in other similar formations. On a fully developed *papilla,* a lateral protrusion is seen, which continues to increase until it has attained to the same diameter as the original. Thus is produced a *papilla* with two heads, which in a longitudinal section, at the rounded ends describe a curve like that of an Italic *8*. This increase of bulk at the head of the *papilla,* cannot, however, take place without also involving the vascular loop contained in it. The accessory head is seen to contain a vessel apparently formed by a projection of the primary loop, and which runs in the interior of the accessory head in a direction pretty nearly parallel with the *8*-shaped curve. It would be a supposition too gross and material to assume that the vessel in the new *papilla* had been intruded into it, as it were; and in a histological point of view this would be a simple impossibility, since the elementary organs of a capillary vessel cannot possibly be so stretched that the vessel should be in a condition to describe a considerable secondary curve, and at the same time suffer no diminution of size, as direct observation shows it does not. We think that the matter may be explained in this way, viz.: The capillary vessel consists, as is known, of extended cells, and when more nutritive material is supplied, as indicated by the increased bulk of the lateral head, the elementary organs of the vessels participate in this *plus* of nutriment, and an increased cell-production will be set up in them, that is to say, by an accelerated process of division new cells will be intercalated between the old ones, and in this way an elongation of the vessel effected. The capillary thus grows into the new, young *papilla.* The growth of the *papillæ* takes place in groups, and hand in hand with it, that of the investing *epidermis.*

The external configuration of the acuminate *condyloma,* doubtless depends upon the mode of growth of the *papillæ.* Thus, in the small, straight forms of this kind of tumour, we find a preponderance of elongated *papillæ* with scarcely any

enlargement of their terminal portion, whilst in the broader *condylomata* a clavate expansion of the ends of the *papillæ* will be observed, and, frequently, not only on the end, but also on other parts of the body of the *papilla*, lateral protuberances will be presented. Thus the greater the preponderance of broad *papillæ* with lateral protuberances, containing convoluted vessels, the greater may be supposed to be the rapidity of growth. The conical points of the *condyloma*, consequently spread out more in breadth, and become flattened by their mutual pressure.

As in other papillary new-formations of connective tissue, forms in a state of involution or atrophy are found to exist, so are they in the present case, and especially in the more voluminous *papillomata*. In many situations such a rapid multiplication of the *papillæ* takes place, that the supply of nutriment is no longer sufficient, and some of the groups of *papillæ* fall into a state of involution, whilst the blood contained in the capillary loop, becomes disintegrated, and yields up its colouring matter, which is deposited in the body of the *papilla* in the form of dark pigment-granules.

The *broad or flattened condylomata* (*papules muqueuses*, Ricord) have as their fundamental *matrix* a new-formation of connective tissue, a statement in which we agree with G. Simon, although we cannot coincide with him when he says, that their structure scarcely differs at all from that of the acuminate *condyloma*, the new-formation of connective tissue, in them, wanting the papillary and dendritic form, and not springing from the surface of the *corium*.

The surface of the broad *condyloma*, as is well known, is smooth, shining, and slightly rounded, and on it a hair may, here and there, be noticed. Usually, also, numerous blood-red points may be seen in the dirty light-red, succulent tissue, and commonly, also, some pale-yellow, scattered nodules, imbedded in the superficial substance. Vertical sections show, that fibrous bands arise from the broad base of the *condyloma*, which expand as they extend towards the periphery (fig. 89, *b*). Towards the surface, on the right side (fig. 89), a few blood-vessels are seen following the same direction as the fibres, and giving off branches at an acute angle. The light-yellow nodules apparent on the surface prove to be swollen sebaceous

follicles (fig. 89, *a a*). In other parts, nothing more than dark streaks remain to indicate the dilated, excretory ducts, which still retain their sharply defined outlines, and should be carefully distinguished from the connective tissue infiltrated with fat. The sebaceous follicles, as well as the hairs, in the broad *condylomata*, are generally rarefied, and usually stunted.

Fig. 89.

Closer examination of the *condyloma* after treatment with carbonate of soda, and the removal of the thin epidermic layer, indicated in the figure by the double contour line, shows it to be constituted of swollen *papillæ*, having at the summit a diameter of 0·075—0·145‴, and each containing a vascular loop. But in no case could a papillary new-formation with dendritic branching of the bands of connective tissue, in the mode exhibited in the acuminate *condylomata*, be perceived. The new-formed connective tissue in thin sections, which should be taken from dried specimens, always displays an areolated disposition. The individual *areolæ* are much expanded, often elongated, and filled with young elements of connective tissue, which, when separated in the fresh state, and more closely analysed, are seen to consist, partly of rounded cells, with a large vesicular *nucleus*, or with one and occasionally two smaller *nuclei*, partly of fusiform cells. The connective-tissue cells are always of small size, and together with a serous fluid, with which the broad *condylomata* are infiltrated, are the main cause of their softer consistence. The connective-tissue-bundles, run in the direction above stated, dividing and decussating in various ways, and accompanied by the blood-vessels. The sebaceous follicles, as well as the dilated excretory ducts, contain a pultaceous, fatty matter, and, usually, flattened cells, approaching nearest to those of the *epidermis*. Sweat-ducts have never been discovered. New-formations of *papillæ* on the surface of the broad *condyloma*, would seem to occur but very rarely.

The *seat* of the broad *condyloma*, from what has been said, must be placed in the *corium*, in whose interstices new connective-tissue-elements are developed within certain circumscribed

limits, which, either being of a softer consistence, remain in the embryonic condition, or become evolved into bundles of connective-tissue, when the new-growth presents a tougher texture. In this local increase in bulk of the connective tissue of the skin, the *papillæ*—its peripheral elongation—must also participate; they increase in circumference, but as has been already observed, in most cases, without the occurrence of any papillary new-formation. But at the same time, the accessory organs of the skin also become involved. The sebaceous follicles sometimes increase in size, when a production takes place of the epidermis-like cells, which, as is known, do not occur in the sebaceous follicles, in the normal condition. But the majority of the sebaceous follicles, as well as the hairs, and most probably, also, the corresponding sudoriparous glands, are stunted.

The discussion of the question, whether the production of the broad *condyloma* is due, simply to a congestive condition, or to an exudative process, we look upon as fruitless, since it cannot be stated where congestion ceases, and exudation begins; and in both processes an increased transudation takes place.

The so-termed *subcutaneous condyloma* of Hauck has been described by Krämer as analogous to the acuminate *condyloma*, though of extraordinarily delicate structure, and seated in the cutaneous crypts. He has found them also in men, and in particular, has often seen them behind the *corona glandis* in the glands of Tyson, with and without the co-existence of *blennorrhœa*.

We have had several opportunities of examining these *condylomata*.. They appear first in the form of semi-transparent vesicles of the size of a pin's head, presenting, in the centre, minute discoid plates, and when compressed, readily assuming a bloody tinge, from the expressed contents. In larger specimens they attain to about the size of a lentil, lose their transparency, and afford on pressure a sebaceous matter, which, however, in proportion to their size, is only in small quantity, and is by no means the entire constituent of the swelling, which feels like a little hard nodule. After the expression of the sebaceous matter, a few pointed, conical processes may be seen projecting, even by the naked eye, but whose contours, on account of the adherent fat, are not sharply defined.

In *condylomata* of this kind, which have been excised, when the superimposed portions of skin is always removed, an oval corpuscle is seen attached to the latter by a peduncle, the longer diameter of the corpuscle being parallel with the surface of the skin; it is usually of a pale, reddish colour. Occasionally a delicate vascular injection may be observed on the curved surface of the follicle. The larger vessels run in the depressions corresponding to the divisions of the lobes (fig. 90), anastomosing by means of connecting branches, and subdividing in the corresponding interspaces into a fine capillary plexus. A vertical section, which is best made by means of a double-bladed knife, displays these structural conditions. We recognize at once the lobate arrangement of the broadish gland (fig. 91), which presents a comparatively thick tunic of connective tissue, from

FIG. 90.

FIG. 91.

which processes *a a* pass between the lobes, and which, indeed, are seen, not only at the periphery, but also among the deeper-seated lobes. Delicate vessels accompany the connective tissue throughout. The contents of the lobes, which appear grey by transmitted light, consist of flattened cells, aggregated into smaller or larger groups, according to the size of the lobe. Individually, they are seen to possess a more or less oval form, and measure, in their longer diameter, on the average 0·123‴; on the addition of carbonate of soda or potass, they do not swell up and become hyaline, like the cells of the horny layer of the *epidermis;* their contents are manifestly fatty.

Towards the periphery of each lobule, layers of smaller cells are visible, which are more or less thrown into polygonal shapes by their mutual pressure, and enclose a comparatively large, oval, granular nucleus. These cells, not only in their form, but also in their regular, lamellar arrangement, precisely resemble those of the mucous layer of the *epidermis.* The

boundary of each lobe, towards the exterior, is formed by a delicate layer of connective tissue, which in less developed *condylomata* of this kind, constitutes merely a narrow, clear streak, and upon the addition of acetic acid, exhibits numerous, irregularly disposed, oval or fusiform *nuclei*. When the interstitial layer of connective tissue is more abundant, minute, delicate, hyaline, hemispherical prolongations of it may be discerned, which thus penetrate from without into the lobules. As the formation of connective tissue advances, the papillary new-growths entering the lobules, ultimately supplant them, and constitute nearly the entire contents of the metamorphosed sebaceous gland, as may be seen when the follicle is opened from above. Krämer gives a figure of a follicle in this condition, taken from a cutaneous crypt at the root of the *penis*; it represents an aggregation of several groups of hemispherical, papillary, new-formations. He describes this form as of rare occurrence, the more usual growths being acutely pointed.

The essential character, therefore, of the subcutaneous condyloma, resides in its being a hypertrophy of the connective-tissue-tunic of a sebaceous follicle, whose parenchyma, that is to say, the gland-cells, are destroyed, and replaced by two layers of epidermis-cells, of larger and smaller size; the former resembling the horny cells of the epidermis, and distinguished by their fatty contents; the second corresponding to the cells of the mucous layer of the epidermis. The interstitial connective tissue, extending inwards, towards the lobules, becomes a papillary new-formation.

The *development* of this *condyloma* may be explained in the following way: an increased transudation is afforded by the nutrient vessels of a sebaceous follicle, or of the two follicles belonging to a hair, in consequence of which the gland is protruded in the form of a minute transparent vesicle, the hair falls out, and there remains the minute dimple-like depression. The vascular injection, in this stage, is proved by the red colour, and the readiness with which bleeding is produced by pressure. The gland-cells of the sebaceous follicle are dissolved in the fluid plasma, and from the peripheral end of the excretory duct, which is lined with epidermis-cells, similar cells most probably continue to arise, whilst from the connective-tissue-coat, a new-formation of connective tissue, and of blood-

vessels takes place. The latter may reasonably be supposed to occur, since in the sebaceous follicles, which are often enlarged to more than ten times the natural size, a close vascular network exists, which cannot possibly have been produced by elongations of the vessels running between the lobules of the gland. The new-formation also, doubtless, takes place, not merely at the surface of the gland, but also in the interstices between the lobules. The development of the newly formed connective tissue advances from the periphery of the gland towards its centre, since the young connective-tissue-substance in the interstices between the lobules increases, and ultimately, as has already been stated, protrudes into the latter in the form of hemispherical *papillæ,* for it may be stated as a general rule, that the new-formation of connective tissue immediately beneath an *epithelium,* and consequently looking towards a free space lined with the *epithelium,* usually assumes the papillary form. In proportion as the formation of *epidermis* on the one hand, and on the other of connective tissue, and of new vessels, advances, the metamorphosed sebaceous follicle becomes more and more distended on all sides; but the growth transversely, and in an upward direction, is the most considerable, in consequence of which, the excretory duct of the gland is rendered shorter, the superjacent skin more and more tense, and the oval nodule more and more protuberant.

It has already been stated, that new-formations of connective tissue are, in general, associated with *suppuration.* This takes place, as is well known, very frequently in the more voluminous dendritic condylomata. Bärensprung has directed attention to this combination, especially in condylomata on the *glans penis,* which frequently attain to a considerable size, ultimately covering the entire glans, and appearing even to be rooted upon its surface. When an ulcerative process, as he remarks, is set up, the affection may readily be regarded as cancerous, a mistake which has occurred often enough, and led to the amputation of the penis. We cannot here enter upon the histological distinction between new-formations of connective tissue and cancer, reserving the point until we come to the consideration of that disease.

Warts, in their structure and seat, present similar diversities to those witnessed in *condylomata;* they consist of new-forma-

tions of connective tissue limited to circumscribed portions of the skin, which are: 1. The *papillæ,* in the case of common warts (*verruca vulgaris*), more properly termed papillary warts. A group of *papillæ* increases in heighth or in width; in the former case the upper part of the *papillæ* is elongated, by a formation of embryonic connective tissue (elliptical and fusiform cells), as it were, into a process which is surrounded by the thickened *epidermis;* in the second case, the width of the *papillæ* is proportionately increased more than their length. Occasionally, minute, contiguous *papillæ* may be noticed, though a dendritic formation has never been observed. The vessels in the elongated *papillæ* do not ascend so high as in the normal condition, nor as they do in the acuminate *condyloma,* and according to Krämer's measurements, the blood-vessels in the latter are about three times as wide as those in warts. G. Simon has observed several vascular loops in a hypertrophied *papilla.* The epidermic layers, especially the horny, appear to be considerably thickened, in the hard, pointed warts. The amount of pigment in the mucous layer, is usually increased in the flattened form of wart. Bärensprung has observed, that hairs and sebaceous follicles are rare in the situations where warts generally occur, and that they are sometimes wholly wanting in the warts themselves; but when they did exist, he noticed that they were quite unaltered. Nor could he perceive any change in the sudoriparous glands; except that their excretory ducts, as in callosities, were not convoluted, but ran in a straight line through the thickened *epidermis.*

2. The *corium* is the seat of the new-growth, in the *smooth warts,* which are of a softer consistence, and placed either on a broad base or on a peduncle. By this new-formation in the *corium* below the *papillæ,* the latter are elevated as it were, but without undergoing any essential change. Nor does the epidermic layer present any alteration, whilst, occasionally, one or more of the sebaceous follicles enlarges and may be recognized by a yellowish point on the surface of the smooth wart. Hairs are usually entirely absent. In many instances the elevated, and as it were, protruded portion of skin, becomes constricted at the base, remaining attached merely by a peduncle of connective tissue, and covered simply by a thin epidermic layer. These smooth warts are often congenital, when like

[some] *nævi*, they retain the same condition through life without any increase or diminution of size.

3. Krämer first noticed the formation of (subcutaneous) warts in *sebaceous glands*, on the inner side of the fore-arm of a parturient woman, in whom, during her confinement, several pustular elevations of the *epidermis* arose, of the size of a mustard-seed, up to that of a lentil, hard to the feel, and presenting the closest resemblance to the pustules of small-pox. When more closely inspected, each elevation exhibited an acne-like point in the centre. When the apparent, dilated cutaneous crypt was squeezed between the nails of the thumbs, this point was, in fact, expressed like a *comedo*, and at the same time by stronger pressure, the orifice of the crypt being more extensively torn, a minute granular tumour was protruded, which sprung from the bottom of the follicle; with a lens, the individual, constituent *papillæ* could be recognized, whose microscopical characters were in all respects identical with those of other warts. By continued growth some of these projections broke through their covering, and formed miniature, pointed warts elevated above the level of the surface. Subsequently Krämer noticed similar subcutaneous warts between the fingers of a child, two years old. Virchow found the same kind of warts, in considerable number, in the region of the chin, in a child.

The papillary warts occasionally assume a peculiar form, in which the horny layers of the *epidermis* covering the enlarged, elongated, and acute *papillæ*, are often elevated in the shape of a slender pedicle. In this way is produced the kind of wart termed by v. Wassenberg, *verruca rhagadoidea*. Schuh designates this kind of growth the *corneous*, or *suberous* wart, and, like Bärensprung, describes the *papillæ* projecting deeply into the epidermic *stratum*, and capable of being extracted after maceration. Suppuration readily takes place in these warts, especially on the lip, when they assume an ulcerated appearance, and as is well known, have frequently been confounded with cancer; they are still, in fact, by many surgeons, regarded as a non-malignant form of labial cancer.

In *lupus* we have a new-formation of connective tissue radiating from a point, and subsequently accompanied with suppuration. The disease commences like a reddish nodule in the

skin, having no defined limits, which soon increases in size, and has been described as the "lupous efflorescence." The section of one of these nodules at once shows the tissue of the *corium* softened by an infiltration, expanded and succulent. Thin vertical sections are more transparent than in the normal state, and afford the following results with respect to the morbid condition of the *corium*. Beneath the Malpighian layer (fig. 92, *a*) there is usually apparent a clear line (*b b*), which represents the boundary of the mucous layer, and forms an undulating curve; the *papillæ* situated beneath it, in two nodules of the kind in question, appeared to be, as yet, unchanged, whilst the *areolæ* in the true substance of the *corium* were more or less distended, and filled with young connective-tissue-elements. The bundles of connective tissue appear very delicate, and to be disposed in rather wide curves (*c* and *e*). The elementary organs lodged in the *areolæ* are very minute, and of various shapes. They are sometimes elliptical cells, with one, or two opposite, short processes (*d*) enclosing a round or oval *nucleus* with a *nucleolus*, and so transparent as to be readily overlooked. After treatment with acetic acid, the *nuclei* are rendered apparent in every part of the section in very large numbers, so that in this case also, a new-formation of connective-tissue-elements may be assumed to take place; and it is these elements, together with the serous fluid, that cause a considerable expansion of the curves formed by the fibrous frame-work, and a diminution of the consistence of the nodules.

Fig. 92.

Hairs have not been noticed by us in these nodules, and the sebaceous follicles, also, were for the most part destroyed, though some of the latter were left in a distended and usually deformed condition, sometimes as rather large lobate remains, with contours less distinctly defined than they are in the normal state, sometimes as dilated excretory ducts. These

distended and partially disintegrated sebaceous glands are visible, even by the naked eye, on the surface of the nodule, like yellowish points.

The *essential nature*, therefore, of the lupous efflorescence consists in a new-formation of connective tissue in the *corium*; which grows sometimes outwards, sometimes inwards, into the subjacent organs. In the former case, the *corium* and *epidermis* are broken through, and an ulcerated spot appears, on whose surface *pus* is usually formed, whilst the new-growth continues to advance in the substance of the *corium*.

The eruption of the growth, externally, takes place in the following way: the epidermis becomes dry and fissured, and exfoliates in the parts affected; and thus is produced the form termed by Hebra, *lupus exfoliativus*. The exfoliated scales, often of considerable size, possess only a slight degree of transparency, partly owing to the circumstance of their being infiltrated with a yellowish, molecular matter, but partly, because minute, elongated air-vesicles, resembling short canals, exist among the epidermis-cells of which the scales are composed. Dried pus, also, may be noticed beneath the scales, in the form of shrunken pus-corpuscles, which, on the addition of acetic acid, exhibit the well-known multifid *nuclei*. The scales are not unfrequently glued together by dried blood. The lanuginous hairs, attached to the scales, are usually stunted, brittle, and split lengthwise, as they are by the action of sulphuric acid. The sebaceous matter of the skin, in the form of fatty masses, occasionally occurs in considerable quantity on many parts of the scales.

Softer crusts, also, are usually observed in this affection, pervaded by a puriform fluid, formed beneath them, in which, besides the pus-corpuscles, brownish-yellow, much diminished blood-discs, whose *hematin* is not extracted on the addition of water, are not unfrequently noticed. Reddish-brown, free pigment is, also, collected here and there in considerable quantity. In a viscid, puriform coating which was brought into view upon the removal of the moist epidermic crusts, a few, strong, elastic filaments were visible, a proof that the deeper portion of the *corium* had also been destroyed by the new-formation.

When the suppurative process commences at the surface of

the *corium*, and the superjacent *epidermis* is gradually thrown off, the form denominated by Hebra, *lupus exulcerans*, is produced. The quantity of pus is comparatively scanty, and it is usually of a viscid consistence. In *lupus*, consequently, fluctuating, hemispherical elevations of the cuticle are rare, though occasionally met with.

The fluid covering the surface of the lupous ulcers presents divers conditions. It exudes in the form of limpid drops, in a circumscribed space, and contains a few aggregated masses of fine-molecular matter, together with a mixture of blood-corpuscles and epidermis-cells. A somewhat more consistent, pale-red fluid on the surface of a shallow, elongated ulcer, exhibited, together with numerous blood-discs, round granular corpuscles, some of the size of, and others less than the blood-discs, and presenting, on the addition of acetic acid, the usual multifid *nuclei* of pus-corpuscles, as a small form of which, consequently, they can only be regarded. The same acid also produced a turbid coagulation in the fluid, caused by straight mucin-filaments woven into a fine network. The dirty-green fluid, exuding from beneath a crust on the inner surface of an ulcer on the *ala nasi*, was composed mainly of disintegrated pus-corpuscles. Many of the round bodies possessed no granular contents, and the *nucleus* was plainly apparent in a reddish hyaline vesicle, or quite isolated, the hyaline vesicle being left. We consider it probable that these hyaline bodies were pus-corpuscles metamorphosed by the imbibition of water. When the dirty-green fluid was removed, a purulent secretion could be obtained by pressure, containing well-preserved corpuscles. The viscid, transparent *mucus* from the cavity of the nose, of which latter nothing remained but the bridge, exhibited, of organic elements, numerous fusiform cells, disposed longitudinally with tolerable regularity at certain distances apart, spheroidal cells of various sizes, and granular pus-corpuscles of different dimensions, disposed in aggregate groups. The streaky opacity so often mentioned (mucin-filaments) was readily produced by the addition of acetic acid, and as readily removed by potass.

The lupous ulceration frequently extends over a considerable surface, when it is often confounded with cancer. We had an opportunity in the *clinique* of Professor Hebra of examining a

very extensive ulceration of this kind situated in the left cheek. The bottom of the sore was uneven and tuberculated, and presented irregular, pale-red, jagged elevations projecting some millimetres above the level of the surface, and separated by deep fissures. In the shallower depressions, numerous convoluted vessels were noticed. The surface of the ulcer was covered with a thin, puriform coating, which was collected in larger quantity in the deep fissures. The edges were sharp and smooth, and the neighbouring integument stretched, polished, and as if cicatrized. On the outer side of the sore were two growths, about 3·54—4·37‴ in diameter, just coming through the skin, and surrounded by the cicatriform *cutis*. The left *ala nasi* was in great part destroyed, and at that part, there was a small suppurating spot. The elementary bodies scraped from the surface of the ulceration were, for the most part, well-preserved pus-corpuscles, with a few, presenting brilliant molecules, indicative of fatty degeneration. Young connective-tissue-elements, however, and groups of large, oval *nuclei*, with 1—2 large *nucleoli* in a hyaline blastema, together with numerous elastic filaments, were visible. Portions of the growth, cut off and compressed, afforded a turbid, but not milky, juice, and which contained merely pus-corpuscles in suspension. In some parts of the surface, the new-formation had assumed the form of elongated, papillary eminences. In the deeper layers, besides the embryonic forms of connective tissue contained in a framework of decussating fibres, vessels existed, but no nerves.

The new-formed cells of connective tissue in *lupus* occasionally attain to a considerable size, equalling that of the cells in well-marked *fungus medullaris*. They will be found, principally, in the very lax, soft prominences, and also mixed with the pus scraped from the surface. Their shape is remarkable on account of its great diversity. Elliptical forms occur with delicate granular contents, a round *nucleus* of tolerable dimensions, and a *nucleolus* of the size of a blood-corpuscle. These cells alternate with others of an oval shape, attenuated on one or on two opposite sides; 3—4 processes may also be seen given off from a cell; and, not unfrequently, cells with two *nuclei* may be observed.

From what has been said, the pathological process appears

to be as follows: The new-formation of connective tissue which, as has been shown above, constitutes the essence of the lupous efflorescence, is at first very limited in extent, and accompanied with injection of the vessels and tumefaction. It gradually extends, and produces a consecutive atrophy of the organs in which it spreads. In the *cutis*, the hairs fall out, and the sebaceous glands and *papillæ* shrink; in a word, the cicatriform, smooth aspect of the skin, above noticed, is produced. In this atrophied condition, the latter is ultimately perforated by the new-growths. A cicatriform contraction, moreover, may remain at one spot, whilst the perforation of the skin takes place at another. The new-formation of connective tissue may, also, extend into the adipose and muscular tissues, or so far even as to affect the bones themselves, and to interfere with the nutrition of the elementary organs, which become, as it were, supplanted by the new-formation, but not dissolved. The new connective tissue may suffer involution in many places, where the conditions for its further development are wanting; but it is not subject to any genuine or spontaneous, retrograde metamorphosis, accompanied by a softening of the new-formed substance. The *pus*, which is so commonly formed in *lupus*, should by no means be regarded, as it has been, more especially by the older writers, as a product of the breaking up of the newly organized substance, or of the normal elements of the tissue; a view which, according to opinions at present received, must be wholly rejected, inasmuch as the pus is itself a new-formation out of a *blastema*, which, in the present case, as in many other instances, is associated with the new-formation of connective tissue.

The *tubera* presented in *elephantiasis Græcorum*, which we have had no opportunity of examining, consist, according to the observations of G. Simon, in a growth of connective tissue in the *corium*, with the formation of rounded granules, containing one or several *nuclei*. (These corpuscles, which have not been more particularly described, may perhaps be the *nuclei* of connective-tissue-cells). They were lodged in a fine meshwork of connective-tissue-fibres, in that portion of the *tuber* which was immediately covered by the *epidermis*. The adipose tissue beneath the *cutis* had disappeared. At the same time, the hair-follicles were enlarged, as well as the

sudoriparous glands, and, as it seemed, the sebaceous glands also. From numerous observations, Danielssen and Böck have placed the seat of the *tubera* in the *corium*, and have observed, in the development of the reddish nodules, the appearance of numerous minute granules imbedded in a transparent, brilliant, whitish-yellow matrix composed of a fibrous network. At a later period, the substance contained in the *tubera* consisted of a similar *matrix*, in which, instead of the granules, an extraordinary abundance of cells was exhibited. These cells were oval, and contained a *nucleus* almost entirely filling them, of a grey colour, and presenting usually 7—8 brown granules. The fibres of the *cutis* were concealed by the above-described substance; the sudoriparous glands could no longer be distinguished; the hair-follicles and root-sheaths appeared thicker than usual, and occasionally split. The sebaceous follicles were sometimes apparently enlarged, sometimes destroyed. The softened nodules contained merely an amorphous molecular substance, in which *nuclei* of the above-described cells were here and there visible. The subcutaneous connective tissue was thickened in proportion to the duration of the disease, though very rarely infiltrated with the tuberculous substance. The tunics of the subcutaneous veins and nerves were found to be thickened.

As a condition allied to *elephantiasis Arabum*, G. Simon notices the swellings which occur, especially on the legs of persons affected with varicose veins, ulcers, or eruptions in that part of the body. In a well-marked case of the kind examined by us, the cutaneous tissue of the leg around the ulcer was considerably thickened, and the surface rendered uneven by several nodular projections. The *papillæ* in the immediate neighbourhood of the ulcer were very much enlarged, and covered by a thin epidermic layer. Each *papilla* was globular and stunted, and infiltrated with a hyaline material. The globular *papilla* was supported by a peduncle, from which a radiating bundle of fibres proceeded. In the hyaline substance were disseminated, rounded and fusiform, immature connective-tissue-elements. The *corium* was much thickened, and infiltrated with a pultaceous, tolerably compact matter, also containing immature forms of connective tissue. The vessels in the dark-red floor of the ulcer formed wide loops,

and the veins in the subcutaneous tissue were here and there dilated in a sacculated manner, and, in general, of considerable size; their walls, when the bloody contents were washed away, appeared opaque, and of a dirty-yellow colour. The interstitial tissue in the affected muscles preponderated so much that the muscular tissue itself appeared to be considerably diminished. The subjacent bones (the lower fourth of the *tibia* and *fibula*) were increased in diameter, and porous, and superiorly they were united by an osseous substance. On the surface of the bones there was a considerable number of flattened osteophytes, looking as if they had been dropped upon it, and besides these, on the opposed surfaces of both bones, elongated, flattened, or acicular osteophytes projected, invested by a layer of connective tissue. In this case, therefore, the new-formation of connective tissue was not limited merely to the *cutis*, but had involved the bones also. The true *elephantiasis Arabum* (*pachydermia*, Fuchs) consists essentially in a new-formation of connective tissue, originating either in the swollen *papillæ*, or in the subcutaneous tissue. The subcutaneous adipose tissue, under these circumstances, may be either atrophied or hypertrophied. There can, perhaps, be no doubt that exudative processes give rise to this new-formation, at any rate, in most instances, the exudation itself being most frequently induced by a varicose condition of the veins, in consequence of which the circulation is so readily impeded.

We think that the cutaneous growth, termed "keloid" by Alibert, should be placed in the category of new-formations of connective tissue. According to Rokitansky (who also refers this affection, on the grounds of probability, to the class of new-formations of connective tissue), the growth occurs sometimes as a simple, flattened, or somewhat raised, or, it may be, depressed induration or callosity of the skin, of inconsiderable dimensions, and of a whitish, or pale-red, or red colour, and sometimes assuming the form of bands,—in either case, frequently running out into white or red elevated lines or processes. In a case examined by us, the affection was situated on the abdomen, and presented to the naked eye, a granulous, pale-red aspect. After extirpation, performed by Professor Hebra, the skin united rapidly. The growth was dried, and sections of it, made in various directions, were examined. A section

made perpendicularly to the surface, and moistened with water, exhibited, beneath a comparatively thin epidermic layer (fig. 93, *a*), the connective-tissue-layer (*b*) consisting of bundles of fibres, containing in their convoluted *areolæ* a dense mass of oval *nuclei*, which are represented of a light colour in the figure. Groups of *areolæ* so filled were encompassed by strong connective-tissue-bundles, which, in many places, existed in considerable quantity. The surface of the *cutis*, it is true, still presented, in many places, elevations and depressions, but in some parts these were indistinct. The subcutaneous, adipose tissue, as well as the sudoriparous glands, the hair- and sebaceous follicles, had disappeared, the new-growth being in immediate contact with the striped muscular fibres.

Fig. 93.

From the preceding facts, it is apparent that this new-formation of connective tissue, originating in the *corium*, induces a destruction of the *papillæ*, hairs, sebaceous and sudoriparous glands, and even of the subcutaneous adipose tissue, in consequence of which the *keloid* assumes a cicatriform aspect.

The comparison of this affection with an *indurated cicatrix* of the skin, will show a striking analogy in the structure of the two. The mucous layer of the *epidermis* frequently presents a considerable amount of pigment. The subjacent layer of connective tissue no longer exhibits the uniform elevations and depressions which are usually presented in the papillary *stratum*. Smooth places are occasionally observed, in a perpendicular section of which, a streak, of a more or less deep yellowish-brown colour (*stratum mucosum*), appears to form a line of demarcation between the epidermic and connective-tissue-layers. The hairs, as well as the sebaceous and sudoriparous glands, are wanting. The subcutaneous adipose tissue is usually reduced to a few scattered fat-cells. The strong connective-tissue-bundles present an areolar disposition, and

from the *areolæ*, numerous fusiform and elliptical cells, with an oval *nucleus*, may often be expressed. The blood-vessels are very scanty. With respect to the development of the cicatrix-tissue, it must be remarked, that it is preceded by a solution of the structures immediately contiguous to the borders of the wound, caused by the exudation. The regeneration of the part by connective tissue probably commences, in part, from the elements remaining in the structure, though certainly not exclusively from that source, as supposed by Reinhardt, since we have often had abundant opportunity of perceiving that embryonic connective-tissue-cells are developed, independently, from the plastic exudation.

The new-growths described by Rokitansky as *cavernous textures* or *cavernous blood-tumours*, which, as he himself says, have hitherto been commonly regarded as *teleangiectases*, consist of a lax kind of connective tissue and, very probably, new vessels. The connective-tissue-fibres, according to him, constitute an intricate, areolated or perforated *stroma*, in which the *areolæ* are lined by a structureless membrane and filled with blood. The numerous caudate cells, which are detached in the examination, appear to him to be the remnants of an *epithelium*. The *areolæ* communicate with each other, as the tumour may be completely emptied by pressure towards the surface of the section. The tumours are surrounded by a tolerably dense capsule of connective tissue, together with which, they may be enucleated from the part in which they are lodged; they always communicate with a considerable vein, from which they may be injected, whilst no arterial ramification can be demonstrated in their texture. From this observation, therefore, it would appear that the blood is contained in the *areolæ* lined with an *epithelium*, and is not enclosed by any independent, solid walls.

Other observers, however, have pointed out the existence of proper blood-vessels. G. Simon describes them as minute, vascular ramuscules and loops; sometimes, also, as of larger size, presenting the appearance of being furnished with small saccular appendages, or as if a few of the larger branches terminated in a cæcal dilatation. He believes, however, that this appearance depends, merely, upon the existence of vascular loops, viewed in such a direction that one side of the loop

conceals the other; he disagrees, therefore, from Lebert in supposing that saccular appendages of this kind on the vessels actually exist in *teleangiectasis*. Although we have had no opportunity of examining the latter affection in the recent condition, still we have no doubt whatever, from the repeated observation of sacciform appendages of the vessels in other forms of tumour, as to their real existence; and we consider, therefore, that these appendages represent embryonic, developmental forms of the vessels, or forms which have remained at a certain stage of development. We think, moreover, that it would be an experiment worth trying, before the extirpation of a tumour of this kind, to touch it with dilute sulphuric acid in the living subject, so as to cause the coagulation of the blood contained in it. The blood-vessels, or *areolæ* filled with the dark reddish-brown substance, would then be readily discerned.

Encysted tumours probably arise, in most cases, from a more or less well-developed new-formation of connective tissue and blood-vessels in the capsule of a sebaceous gland; and certainly the cases are but rare in which a tumour of this kind, with atheromatous or melicerous contents, originates in the subcutaneous connective tissue.

The usually pultaceous contents of encysted tumours consist, for the most part, of epidermic cells, which are rolled together into a laminated mass, are separated from each other with difficulty, and then, apparently, present a fine network of filaments. After the addition of carbonate of soda or potass, the epidermic cells swell up, assume a rounded shape, and separate from each other; and, at the same time, an abundance of *cholesterin*-plates deposited among the layers of cells, is brought into view. The much flattened and thin epidermis-cells, when softened with water and treated with acetic acid, present a vesicular, hyaline *nucleus*. The cells are of various sizes, like those of the mucous and horny layers of the cuticle; their great number is manifested by the opacity, greyish colour, and pultaceous consistence of the contents of the cyst. The contents of the epidermic cells are altered and present a fatty aspect. Cells of this kind are more or less rounded, though always retaining a flattened shape; and, besides this, they are separated from their neighbours by the action of carbonate of soda or potass, just as readily as the common epidermic cells; their surface,

also, is never so smooth as that of the fat-cells, which, moreover, in the fresh condition, always exhibit a spherical form, and usually exceed in size the epidermic cells filled with fluid fat. We think that the encysted tumour described by J. Vogel contained such fatty epidermic cells, for he says: "the contents consisted, besides the hairs, entirely of colourless cells filled with fat (like the common fat-cells), and in close contiguity. No vessels could be seen among the fat-cells." But in newly formed collections of fat-cells, blood-vessels are always met with; and it sounds strange also, that the shafts of the hairs should be surrounded with true fat-cells.

The epithelial cells of the encysted tumour, towards the inner surface of the wall of the cyst, are disposed more irregularly and more closely together, constituting a membranaceous coating.

Besides the above-mentioned *cholesterin* plates, fat occurs also in the form of globules and crumbly masses, which latter, however, must be carefully distinguished from the calcareous salts occasionally deposited in tumours of the present kind; the difference will at once be ascertained upon the addition of reagents.

The *wall* of the cyst is usually very thin, and consists of decussating connective-tissue-bundles, parallel with which blood-vessels may occasionally be seen running. Hairs and sebaceous follicles, also, are not unfrequently seated in it; and Kohlrausch has even noticed sudoriparous glands. A subcutaneous, encysted tumour, in the neighbourhood of the eyebrow, of a rounded form, and about 0·39″ in diam., which was removed by Professor Schuh, presented a delicate wall, very vascular on the inner aspect, the blood-vessels forming a close mesh-work and elongated loops. When a layer of very lax connective tissue was stripped off from the inner surface, whitish points were brought into view, which proved to be enormously distended sebaceous follicles, and appeared occasionally to be perforated by a hair. The bulbs of the latter were elongated and scarcely at all enlarged; the medullary substance commenced at a greater distance from the bulb than is usually the case, and existed in many hairs not thicker than the larger kind of *lanugo*. The thickness of the hairs varied from that of the *lanugo* to that of a thin hair of the head. They were very loosely

implanted in the wall of the cyst, and readily fell out. The contents of the cyst were a gelatinous substance, with whitish, scattered points, the latter consisting of collections of epidermic cells; in the former were simply groups of molecules.

In more rare cases, horny growths have been seen protruding from encysted tumours. Horns of this kind gradually perforate the skin, and continue to grow like the nails. J. Vogel, who has had several opportunities of examining horns attached in a follicle, describes them as being of a corneous substance which can be readily cut and scraped. Under the microscope, the substance itself appears quite indeterminate, almost amorphous, like that of the nails; but when digested for some time in caustic potass, the tissue breaks up into minute scales, exactly like those which are obtained by the same means from the substance of cutaneous callosities, corns, &c. He, therefore, describes these horns as local growths of the epidermis of the cyst.

Thus, in these cysts, all the parts belonging to the skin may be formed, as the horny and mucous layers of the epidermis, a vascular connective-tissue-layer having hairs implanted in it, and furnished with sebaceous and sudoriparous glands, and even nail-like horns; or, in other words, the tumour may become a portion of encysted integument, whilst, in the subcutaneous warts, or *condylomata*, merely a papillary new-formation takes place on the inner surface of the hypertrophied connective-tissue-tunic of the sebaceous follicle. The shedding of the epidermic cells and hairs goes on in the tumour exactly as on the external skin; but these parts, as well as the sebaceous matters, and the secretion of the sudoriparous glands, not being removed, necessarily accumulate in the cyst.

The growths described by many authors under the name of cutaneous *polypi*, also belong to the class of new-formations of connective tissue, occurring in circumscribed portions of the *corium*, and inducing a destruction of the *t. adnexa*. From a *polypus* of this kind, situated on the external auditory canal, when dried, very thin sections could be made, which presented two principal layers, an epidermic investment (fig. 94, *c*), with the horny and mucous layers, and a *stratum* of connective tissue, consisting of an areolated fibrous *stroma*. The larger, wider *areolæ* were situated towards the base of the little

tumour, and gradually diminished in size towards the cuticular surface, the fibrous framework appearing proportionately more close (*a*). The *areolæ* were, at any rate, some of them, filled with elementary bodies, which could only occasionally be distinguished as cells (*d*). In another case, of a similar growth, extirpated by Dr. Türck, these elements consisted of elliptical and oval cells, furnished with one or two processes (*f*), and containing a *nucleus* and delicate molecular substance. In longitudinal sections taken from the former tumour, when dry, and examined under a lower magnifying power, light-coloured, broad *striæ* could be distinguished, from which, not unfrequently, a clear branch was given off (*e*); the outlines of the streaks were not sharply defined, and sometimes they appeared short and truncated. These light-coloured streaks could not in any way be regarded as lymphatics; and merely represented a hyaline *blastema*, collected in the intercommunicating areolar passages. Not a vestige of lanuginous hairs, sebaceous glands, nor of the excretory ducts of the ceruminous glands, could anywhere be perceived, nor could any elastic filaments be discerned.

FIG. 94.

The small cutaneous tumours described by many authors under the name of *molluscum simplex*, or *non contagiosum*, which are sometimes sessile, sometimes pedunculated (in which case they have received the name of *m. pendulum*), have also been recognized by Rokitansky as growths of connective tissue. We, also, have observed in these tumours only a fibrous framework enclosing minute connective-tissue-cells; and, in an elastic, soft *molluscum pendulum*, about the size of a pea, from the pelvic region, we noticed that the surface was smooth, the epidermic covering thin, and the pigment layer

well developed; but that hairs, sebaceous follicles, and sudoriparous ducts were wanting.

Besides the above, *a multitude of names* have been applied to the cutaneous new-formations composed of connective tissue, according to the diversities in their *conformation*. These diversities depend upon various circumstances: 1. *Upon the stage of development at which the formation of connective tissue remains.* Formations of this kind are met with, especially in the subcutaneous tissue, presenting a gelatinous appearance, and in which the development of the elementary organs remains at an embryonic stage. Their consistence is gelatiniform, and pretty solid; when divided, their colour is light yellow, and, in moderately thin sections, they exhibit, in most parts, a considerable degree of transparency; only a very small quantity of clear, transparent, rather glutinous fluid can be expressed from them, and occasionally *lamellæ* of the same texture may be separated; in many cases they are found to possess great fragility; they are always but scantily supplied with blood-vessels. These formations constitute abruptly defined, occasionally very extensive tumours, and not unfrequently perforate the skin, which had previously been atrophied by their pressure. They never exhibit any disposition to softening, and it is only after the skin has given way that they are subject to a superficial suppuration, which should not be confounded with softening; on the other hand, after extirpation, they are very liable to be regenerated, although, at the same time, they have no tendency to appear in several parts of the body. Manifest transitional forms exist from these gelatinous tumours to the fibrous. Their consistence becomes denser, the colour approaches more nearly to white, and, in conformation, they are, not unfrequently, lobate; the areolar texture is more distinct, and sometimes, in fact, cysts are developed, or fissure-like *areolæ* filled with a serous fluid.

In his latest work upon 'Gelatinous Cancer,' Rokitansky, with reference to non-malignant gelatiniform tumours, also adopts the view that they represent simply embryonic connective-tissue-formations. The *collonema* of J. Müller, a lax, transparent, gelatiniform, quivering mass, contains principally embryonic, isolated, or aggregated elements of connective tissue, imbedded in a structureless, transparent substance.

The latter are, not till afterwards, developed into fibrous bundles, which, consequently, though at first scanty, gradually become more and more abundant. *Collonema* thus approaches the nature of a fibrous tumour.

The *gelatinous sarcoma* has been divided by Rokitansky into several varieties, distinguished merely by the various stages of development of the connective tissue. The *albuminoid fibrous tumour* of J. Müller is regarded by him as a distinct species of this form of *sarcoma*. It is described as an albuminous, glutinous tumour, composed of a white or whitish-yellow, solid, friable substance, of a tuberous aspect, and very scantily supplied with vessels, which exist only in the redder and softer portions.

Schuh is of opinion that all the friable growths, which can be more or less readily split into *lamellæ*, and contain gelatin and albumen in their composition, should be referred to *carcinoma fasciculatum*.

When the above-described, transitional forms of the gelatinous connective-tissue-tumour are more developed, so that the fibres ultimately constitute the principal element—the amount of connective-tissue-cells, the elliptical and fibre-cells (Virchow's "connective-tissue-corpuscles"), being diminished in proportion and existing only in very scanty numbers—we have a fibrous connective-tissue-tumour, to which, also, numerous names have been assigned—as fibroid, desmoid, fibrous *sarcoma*, fibrous *polypus*, and *steatoma*. We shall afterwards show that the fundamental character of all these forms is that of connective tissue.

2. The conformation of these growths depends upon the *form*, *size*, and *contents* of the *areolæ*. The latter may be either round, oval, or elongated; minute, or dilated to such a size as to appear like cysts; and they may contain a thin, albuminous fluid, or colloid matter. These tumours have been termed *cysto-sarcoma* and *colloid tumours*.

3. The *elastic tissue* is often wholly wanting in this kind of cutaneous tumours, though, again, it may exist in very considerable quantity, and the new-growth thence assume a greater degree of consistence.

4. *Adipose tissue* frequently occurs disseminated in the tolerably consistent connective tissue, in those tumours which

have received the name of *steatoma*. Schuh is indisposed wholly to reject this appellation, which has been entirely given up by several later writers, and claims for these tumours a well-marked glandular structure.

5. *Blood-vessels* in considerable abundance, or *blood* in large quantity, are found in the contents of the cutaneous tumours, composed of connective tissue, which have been described under the name of "*fungus teleangiectodes*."

6. An abundance of *pigment* occurs in non-malignant *melanosis* of the skin.

As illustrative of the above statements,[1] the following cases may be recorded.

A tumour composed of embryonic connective tissue was extirpated by Professor Schuh, from the subcutaneous tissue on the forehead. The tumour, which was about 0·96″ in diameter, was rounded, and the cut surface smooth, dry, of a lightish-yellow colour, and transparent at the edges, of a tolerably firm consistence, about equal to that of the liver, which organ it also resembled in its friability; it was contained in a capsule of connective tissue, and was very scantily supplied with blood-vessels. The embryonic connective-tissue-elements were very minute, and could be isolated only after the texture was loosened by maceration in water, by which the intercellular, connecting glutinous substance was dissolved. Fusiform elements, presenting short processes, and an oblong *nucleus*, were the principal constituent; elliptical cells were more rare. The disposition of these elementary organs could be best seen in fine sections treated with acetic acid, by which the *nuclei* were rendered evident, in their natural position (fig. 95, *a a*). Darker spaces might be seen, bordered by lighter; the acetic acid having manifestly, somewhat diminished the transparency of the thin *lamellæ*. The *nuclei* in the rounded, more opaque parts, were surrounded by several systems of other, elongated *nuclei*; and in the interstices between the concentric nuclear *lamellæ*, oblong *nuclei* were again apparent, ultimately constituting a capsular investment surrounding an entire group composed of opaque portions. The disposition of the oblong *nuclei* presents

[1] The author here gives the details of several cases, to illustrate the account of these growths offered above, but as some of these instances seem to involve needless repetitions, the editor has omitted several of them.

a remarkable analogy with that of the bone-corpuscles, especially as they are seen in the transverse section of a long bone. In some sections, also, a few isolated fat-cells (*b b*), often arranged in rows, could be perceived, sometimes imbedded in an embryonic connective tissue, sometimes lying among the rarefied elastic filaments (*c c*). In the base of the tumour, a few minute nodules were visible, which were rather more compact than the large lobes, though not differing in structure. The superjacent integument presented no striking anomalies.

Fig. 95.

This tumour appears to have originated in the interstitial connective tissue of the fat-cells, and it may also be doubted, that the scanty fat-cells and the elastic filaments were a new-formation. The tissue of the *corium* had not suffered in consequence of the new-growth. With respect to its definition, we maintain, that anatomically, it must be regarded as an embryonic connective-tissue-tumour. In Rokitansky's classification it manifestly belongs to the class of gelatinous *sarcoma;* and Schuh, in his comprehensive term of *carcinoma fasciculatum,* would probably regard it as an instance of that disease.

A little nodule, about the size of a lentil, immediately under the skin of the knee, from an account afforded by Professor Schuh, had caused the patient the most acute pain, so that his whole body shook if any one approached the tumour with the finger. When removed, a very slender, white filament remained hanging to the tumour, which was supposed to be a nerve, but examination proved that it consisted merely of connective-tissue-fibrils belonging to the capsule of the nodule. Even after the application of carbonate of soda, not even a single nerve-tube could be demonstrated. The small tumour could be easily enucleated from the superjacent skin, and had a rounded form and pale colour; the consistence was so soft, that its contents might almost have been supposed to be a

viscous fluid. A perpendicular section showed that it was composed of a soft, light-yellowish substance, containing a few, scarcely visible, bloody points. A rather tense portion of connective tissue, proceeding from the consistent capsule of the tumour, which was also composed of connective tissue, divided the enclosed substance into two segments. The soft, light-yellow material consisted of very minute elements, scarcely larger than a blood-corpuscle; these were cells, some rounded, some angular, with a comparatively large, oval *nucleus*, which filled nearly the whole of the cell, so as to leave merely a narrow border composed of the rest of the cell-contents. The fusiform cells were furnished with short, stunted, opposite processes, and also contained an oval *nucleus* of comparatively large dimensions. The latter cells appeared to be grouped around the former, as was evident from the disposition of the *nuclei*, in minute portions treated with acetic acid. Not a trace of nerve-substance, could be discovered in the interior of the nodule. A portion of the tumour, dried and again moistened with acetic acid, presented only a few, isolated, slender, convoluted, elastic fibres, in the substance; they were found in larger number in the above-mentioned tense dissepiment composed of connective tissue. Blood-vessels certainly existed in but very small numbers in the interior, but were more abundant in the capsule of the tumour. The superimposed skin presented nothing abnormal, nor did the subcutaneous tissue.

The anatomical examination, therefore, in this case also, showed a new-formation of connective tissue, which, at any rate, for the most part retained an embryonic character. The seat and point of origin of this small tumour must be left undetermined. At all events it is possible that the peduncle, composed of connective tissue, was in connexion with a bundle of primitive nerve-tubes, which had been divided in the operation; and it might, moreover, be conceived that the capsule and the interstitial connective tissue of a bundle of primitive nerve-tubes may have been the point of origin of the new-formation, and that the touching of the nodule was painful, only through the intermediation of the band of connective tissue. As the tumour was not seated in the continuity of a nerve, it cannot be described as a *neuroma*, but as representing merely the *tuberculum dolorosum* of the older writers.

There can be no doubt that fibres of connective tissue constitute the principal element of many of these tumours, which may thence be termed *fibre-cell-tissue-tumours*, at least in an anatomical sense. They appear to arise in the deeper part of the corium, and the superficial portion of the adipose layer. From this point they continue to grow, circumscribed within certain limits, and elevate the corresponding part of the skin, probably inducing in it, when stretched beyond a certain degree, an obliteration of the nutrient vessels, and consequently its atrophy.

§ 3. Subcutaneous adipose tissue and Interstitial tissue of the muscles.

It is well known that the little adipose masses visible to the naked eye are composed of groups of fat-cells, enclosed in tolerably strong bundles of connective tissue; and that the latter are associated with numerous elastic fibres, vessels, and nerves. Now from this connective tissue, existing so abundantly among the groups of fat-cells, in many cases, a new-formation of the same tissue appears to originate and secondarily to induce an atrophy of the fat-cells. We have examined embryonic, connective-tissue-formations in the adipose tissue, particularly beneath and in the neighbourhood of what are termed chronic varicose ulcers. The adipose tissue in these instances assumes a pulpy aspect, the fat-cells are diminished in size, appear isolated, and in their contents one or several fat-globules may be noticed, suspended in a hyaline fluid; in a word, they exhibit precisely the same conditions as do the cells described under the head of "atrophy of the adipose tissue." We have not, as yet, had an opportunity of investigating the nature of *elephantiasis Græcorum*, but from the anatomical *data* afforded us by Danielssen, we learn, that in many cases a partial degeneration of the fatty tissue into cellular [connective] tissue, constitutes the proximate cause of the disease: and that the new-growth of connective tissue extends among the muscles as far as to the bones.

In speaking of the atrophy of muscles, we adverted to a new-formation of connective tissue in which the muscle was

gradually converted into a ligamentous band. But, besides this, a new-formation of connective tissue remaining at an embryonic stage of development, is likewise, though perhaps rarely, observed to occur in the muscles. We have met with but two decided cases of this kind. One was that of a voluminous tumour extirpated by Professor Schuh: it was seated on the *pectoralis major*, and so closely connected with it that an immediate transition existed between the substance of the base of the tumour, and that of the muscle. On the sides, the growth was covered by a capsule of connective tissue, in many places of considerable thickness. When this was reflected, an irregular, uneven mass, partly of a greyish-yellow, in parts of a greyish-red colour came into view, on whose polished surface no differences in texture could be distinguished. The consistence of the flattened nodules, which were transparent at the border, was about that of coagulated *gelatin*. The structure was foliated, and it was rendered more apparent in a nodule which had been placed in boiling water, by which the substance was rendered extremely friable. From a portion prepared in this way, it was more distinctly shown that each nodule or tubercle consisted of two cones flattened on each side, whose bases were directed towards the surface of the tumour, and which could again be split in the direction of their length. The radiate disposition of the fibrous *lamellæ* was most distinct towards the centre of the tumour. The surface of a section appeared smooth, and homogeneous, and, by pressure, only a small quantity of a clear yellowish, viscid moisture could be obtained. The shades of colour, particularly of red, were rendered more distinct when the corresponding portions were treated with dilute sulphuric acid, by which the parts, infiltrated with *hematin* and exhibiting only a faint tinge of red, acquired a more or less intense, brownish-red hue. Towards the centre of the tumour, vessels with thin walls, and blood-sacculi could be seen, but in general a great scarcity of vessels was noticed, nor were any of capillary dimensions, visible. In other parts, also towards the centre, there were simply blood-red spots without any defined boundaries. The flattened nodules were parted by a delicate, fibrous layer of connective tissue.

The histological examination showed, in all parts, nothing

but minute cells, mostly of a fusiform shape, with two short, opposite processes, an oval *nucleus*, and a distinct *nucleolus*. These cells were disposed parallel to each other, as it were, wedged together, and occasionally, when the central part was slenderer, exhibited oblong *nuclei*. The elliptical cells, with a more rounded, also comparatively large *nucleus*, occurred less abundantly. Granule-masses were accumulated in considerable quantity, especially in the neighbourhood of the more vascular spots; they were imbedded in a pultaceous, deep-yellow substance, which was lodged in the deeper layers of the tumour, and were disposed in tolerably symmetrical, longitudinal rows. In the same situations were collections of larger and smaller fat-globules. In boiling water, the growth lost its transparency, was rendered opaque, and like coagulated albumen. Acetic acid also produced some degree of opacity, and, under its influence, fine sections assumed a brownish-yellow colour, and, on account of the diminished transparency, the *nuclei* were distinctly visible only at the borders of the preparation. In the alkaline carbonates, the substance became more hyaline, and exhibited little more than a fine-molecular character.

In this case, the predominant character of the tumour must be allowed to be that of a new-formation of connective tissue, distinguished by the embryonic form of its elements, and the remarkable contents composed of fluid albumen associated therewith. The fibro-foliated structure may be accounted for, on the supposition, that the new-formation took place in the longitudinal *areolæ* of the interstitial tissue of the pectoral muscle, in consequence of which the muscular substance was removed.

But the question still arises, as to whether the new-growth should not be ranked with those which have been described by J. Müller as *carcinoma fasciculatum*, and of which Rokitansky relates only one accurately examined instance taken from the mammary gland. The tumour just described certainly presents considerable analogy with *carcinoma fasciculatum*, but we think, that in a purely anatomical point of view, it must be described as belonging to the class of growths composed of embryonic connective-tissue, since it exhibited neither an areolar *stroma*, nor that diversity and difference in the evolution and involution of the elementary constituents, which might have

been expected to exist in a growth of such considerable dimensions, had it been of a cancerous nature. According to Schuh's classification, the above-described tumour must, indisputably, be referred to *carcinoma fasciculatum*. In a large experience of cases of this kind, Schuh has never observed the general health to be perceptibly affected, the glands of the *axilla* were never enlarged, and the aspect of the disease presented no peculiar characters, and could not be distinguished from a *steatoma* or *cysto-sarcoma*. The degree of malignancy he describes as very small. But he is, nevertheless, of opinion that the disease must be explained as of a cancerous nature, since it is occasionally painful, is readily regenerated, and a liquefaction may take place in the midst of the substance in consequence of suppuration. But in the present confused notions of what is to be termed *cancer*, we may be allowed, at any rate, to place a mark of interrogation against the cancerous nature of the case just described.

A white, yellowish-grey tumour, of about the size of a walnut, abruptly defined, and presenting a granular aspect on section, was removed by Professor Sigmund from the pectoral muscle. It consisted wholly of minute cells, usually of an oval form, with a large, oval, nucleolated *nucleus*, occupying nearly the whole of the cell. Fusiform cells were more rare; these were very small, short, and occasionally so much attenuated in the body, as to present a rod-like figure, acuminate at both ends, not unlike that of acicular crystals, but for which they could not be mistaken, even upon superficial examination, since they did not possess the sharp, angular outline of a crystal. These elementary bodies were readily disengaged, and presented everywhere the same characters. Indications of fibres were very rarely presented, and those of very delicate dimensions.

We shall here add the description of a few tumours of connective tissue, differing in morphological character, and whose systematic position cannot be assigned with certainty.

An encysted subcutaneous tumour, seated, probably, upon the tendinous sheath of the *masseter* muscle, of a rounded form, and about 0·96‴ in diameter, was removed by Professor Dumreicher. It had required two years to reach these dimensions, and, except quite latterly, had caused no pain. Its consistence was tough, the colour greyish-yellow, and it was

pervaded by only a few blood-vessels; the structure was granular, though not in all parts, for in places the granular structure was replaced by a still more consistent paler substance. The yellowish granules contained the following elements: 1. Rounded and oblong-cells (fig. 96, *a*), with a round or oval, nucleolated *nucleus*, which was sometimes double, and fine-granular contents. 2. Cells with two opposite filamentous processes, and one or two *nuclei*, which were more elongated in proportion to the attenuation of the body of the fusiform cell; whilst other cells with several sub-dividing processes (multipolar connective - tissue-cells) were presented in the most manifold forms. These cells were connected by their processes with a fine filamentous net-work (*b*), which itself was brought more distinctly into view upon the addition of acetic acid, or of carbonate of soda or potass, and could be traced into an almost invisible, excessively delicate *plexus*. This net-work presented in all respects the morphological and chemical characters of a fine elastic tissue, and was most abundant in the denser portions of the growth. The groups of cells constituted rounded masses (fig. 96, *c*, 1), whence, those which were placed at the border of the mass were viewed on the edge, and a rosette-like figure was produced. In one of the large groups, the cells could be observed in close apposition, in great numbers (*c*, 2), when they were not unlike epithelial-cells. Occasionally, also, they occurred in lengthened rows (*c*, 3), either simple or several together. The cells were lodged in the *areolæ* formed by the connective-tissue-bundles and elastic fibres.

FIG. 96.

This tumour, whether it be termed *sarcoma*, *fibroid*, or *steatoma*, represents, nevertheless, a new-formation of connective and elastic tissues; the latter of which, either in the normal or in the pathological condition, never occurs alone, but always associated with the former. That the elastic fibres were not, in any way, a mere *residuum* of the original tissue, may be

positively asserted, since their quantity was very considerable. This was even more evident in the following case.

A tumour about the size of the closed fist, was situated in the region of the parotid gland; the skin covering it was moveable; it presented several tubercular elevations, indistinctly fluctuating. It was twelve years in reaching its present dimensions, had caused no pain, and was not accompanied by any perceptible constitutional affection. The extirpation was undertaken by Professor Dumreicher. The growth was separated from the neighbouring parts by a capsule of connective-tissue. In a section of it, two kinds of substance could be distinguished, one gelatinous and quivering like jelly when shaken, the other yellowish and tough, which latter, also enclosed gelatinous lumps of the size of a pea, contained in a kind of capsule. The surface of the section was rather dry, and only a very small quantity of clear juice could be squeezed out. The cells were of small size, and the rounded, as well as the fusiform, frequently contained two *nuclei*; the *nucleoli* were very distinct. The *nucleus*, in proportion to the size of the cell, was large and usually of an oval form; only the cells in the gelatinous substance exhibited a vesicular *nucleus*, encircled by fatty molecules. In the yellowish tough parts, the elastic filaments constituted the principal element (fig. 97). The

FIG. 97.

largest of these equalled in size the thicker filaments in the subcutaneous tissue; they were frequently bifurcated, and at the point of division, when they were favorably placed, a toothed border could be seen on one side. Two or three rather large filaments often ran together in the same direction, separating ultimately, and when ruptured, curling up in a tendril-like manner. Occasionally also, short anastomosing

ramules could be perceived among the thicker branches, whence fissure-like interstices were produced. The slenderer filaments, just like the thicker ones, were much convoluted, and, occasionally, spirally contorted, or bent into a hook at the end, whilst, in other places, they terminated in a very close and delicate filamentous network. It was obvious, that the whole elastic network resisted the action of acetic acid, and of carbonate of potass, whilst the connective-tissue-bundles, and few imbedded cells, disappeared on the application of those reagents.

In order to study tumours of this kind, in section, and to display, satisfactorily, their areolar arrangement, either portions not too thick, may be simply dried, or a larger portion may be boiled in acetic acid, and then dried. It is advantageous also in many respects, to treat sufficiently thin sections with a weak solution of carbonate of soda.

§ 4. Mucous membranes.

New-formations of connective tissue, though undoubtedly very frequent in these membranes, have hitherto not been submitted to very precise investigation. Like those of the external integument, they occur, sometimes as dendritic, papillary new-formations, on the surface of the membrane; or as embryonic or fibrous new-formations, seated in the parenchyma of the membrane, and in the submucous tissue.

We once had an opportunity of examining an *acuminate condyloma,* situated upon the *uvula,* and which was removed by Professor Sigmund, and found it to be constituted exactly like those seated on the external integument. The bleeding consequent upon the operation, rendered it impossible to trace the blood-vessels with any accuracy; but the common epithelial covering could be readily made out, spread over a numerous group of mostly short, cylindrical, and clavate *papillæ,* which were disposed in an umbellate manner.

The *urethral caruncles,* as they are termed, especially in the female, are also dendritic, papillary new-formations of connective tissue. We received from Professor Chiari, a very vascular tumour, which he had met with in the dead subject, at the orifice of the female urethra, in the vestibule. It was of a

somewhat elongated figure, above 0·5‴ in length, and 3·1—3·5‴ in diameter, of a bluish-red colour, and spongy texture, and exhibited, when cut into, cavities containing colloid matter. The surface was smooth, marked with shallow indentations, and evidently covered with *epithelium*. The *matrix* of the growth was constituted of embryonic connective-tissue. The most interesting point was the distribution of the blood-vessels, which could be very distinctly traced in transverse sections, moistened with a solution of sugar, or of common salt. The ramification of the vessels precisely resembled that witnessed in the *vasa vorticosa*. Several considerable sized vessels entering one of the lobules, divided into a multitude of smaller ones, which, though not of capillary dimensions, made numerous undulating curves, extending up to the periphery of the lobule, where they terminated in mostly short and abrupt loops (fig. 98, *a a a*). In favorable situations, a more voluminous vessel might be noticed towards the base of the lobules, which appeared to return the blood from the periphery. The structure of the walls of the vessels, was everywhere simple, resembling that of the capillaries in the normal condition; no distinction, therefore, could be drawn between arterial and venous canals. The red blood-corpuscles contained in these vessels were remarkable from the smallness of their size, which did not reach beyond 0·0017—0·0022‴, whilst it is usually 0·0033‴. The blood moreover, in spots, had escaped into the parenchyma of the tumour; and in many places also, brownish-black pigment granules (necrosed blood?) were collected in considerable abundance.

FIG. 98.

These caruncles are sometimes met with in great numbers, and of firmer consistence. Schuh has observed that they frequently return after extirpation, since, even when the urethra has been slit up to some extent, minute remains of them may easily be left. When they return, he has occasionally found

them to be of firmer consistence, and involving even the *clitoris* and a portion of the *vagina*.

In cases of hypertrophy of the *uterus*, when the lips have a soft feel, we have repeatedly seen the *papillæ* considerably enlarged, with the vessels more numerous than in the normal condition, more serpentine in their course, and dilated. But, in these cases, we have been unable to detect any dendritic formation of connective tissue.

It is highly probable that the *cauliflower-like polypi of the larynx*, described by Ehrmann, and which have been termed epithelial cancer (epidermic cancer, cancroid) by Rokitansky, also belong to the category of dendritic, papillary new-formations of connective tissue. According to the latter observer, they are cauliflower-like, whitish-red, vascular excrescences, seated, either upon a peduncle of connective tissue covered with the mucous membrane, or upon a broader base. They constitute small, distinct tumours, or, growing in close contiguity with each other, cover a more extensive space, or even the whole of the mucous membrane of the larynx. They spring either from the mucous membrane, or are more deeply rooted, growing, that is to say, from the submucous tissue, frequently from a degeneration of the arytenoid cartilages, or even of the whole of the walls of the larynx.

The *gums* are, without doubt, frequently the seat of a diffuse new-formation of connective tissue. In a paraplegic person affected with scurvy, the gums were of a bluish-red colour, and so much swollen as to be nearly level with the borders of the teeth. When incised, there was presented, beneath the thick epithelial layer, a stratum of a dark-red colour, not unlike the crassamentum of blood, which contained, however, not simply blood-corpuscles, but also a considerable quantity of embryonic connective-tissue-elements, together with granules of yellow, reddish-brown, and black pigment. The connective-tissue-cells were elliptical, oval, or elongated, the latter furnished with a single process of greater or less length, or with two opposite processes. The mostly oval *nuclei*, with a projecting *nucleolus* were frequently double in these cells.[1]

[1] [The plastic nature of the scorbutic exudation, has been before adverted to (*vid.* note, p. 234), and is sometimes manifested in the most remarkable way in the gums. We, not long since, observed a case in the Seaman's Hospital, in which a

A *sacciform appendage** is occasionally seen to remain attached to the root of teeth that have been extracted. In a case that fell under our observation, in which the tooth was carious, the growth was of about the size of a large lentil, had a rounded surface, was very vascular, and of a loose spongy structure. The vessels were serpentine, and collected into coils, the interstices being filled up by a delicate fibrous tissue and immature connective-tissue-elements contained in a hyaline *blastema*. Growths of this kind occasionally suppurate internally, and constitute the well known closed abscesses at the root of the teeth. The new-formation, in these cases, must arise from the *alveolus*. A layer, 0·44‴ thick, of new-formed connective tissue abundantly supplied with vessels, was observed by us on the neck of a molar tooth, whose pulp had become disintegrated into a dark-coloured, pultaceous substance composed of organic *detritus*. The development of this new-formation, in particular cases, owing to the copious supply of nerves to the alveolar *periosteum*, may perhaps be attended with pain.

A tumour of about the size of a pea was situated in the substance of the *tongue* on its inferior aspect, and on the posterior part of the middle third of the organ, which was extirpated by P. Dittel. It was surrounded by a membranous capsule of connective tissue, was pale and resistant, presenting, on the surface of a section, numerous, scattered, just perceptible, yellowish points, which, when compressed on both sides, projected a little, and appeared as structureless, hyaline, flocciform plates of irregular size, superimposed one upon another; their borders were fissured, and they were not altered by acetic acid. The remaining elements, which could be obtained only in small quantity, by pressure, were minute connective-tissue-cells in various transitional forms. Sections made, both in the moist and in the dry condition of the tumour, displayed

complete bridge was formed across the palate by the inosculation of scorbutic vegetations springing from each side. After the removal of all appearance of scurvy in the tissue of the gums, this bridge remained fully organized, covered with a normal epithelium, and when removed and examined, it presented a structure in all respects corresponding with that of the gums. No more striking instance can be afforded that the scorbutic effusion is not *blood* in the proper sense of the term, but a peculiar, fibrinous, plastic exudation.—Ed.]

the *areolæ* enclosed by bundles of connective tissue, and filled, at any rate the majority of them, with the same amorphous masses. The latter must probably be regarded as solidified colloid matter, which had been secreted, in the fluid state, into the dilated *areolæ*. The tumour itself was manifestly one of the fibro-cellular kind.

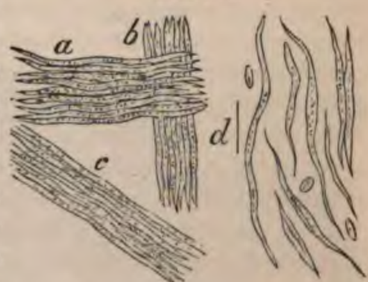
The growths of connective tissue described as *polypi* of the *throat* and *nose* have only once been examined by us. The pharyngeal *polypus* was seated on the posterior and upper wall of the *pharynx*, it was of colossal dimensions, highly vascular, and very firm, especially towards the periphery, where it was of cartilaginous consistence; towards the centre, the consistence was less, as well as the redness. Abundant reticular, elastic tissue was visible in all parts, and it was owing to this that the connective tissue bundles included in the tough substance could be displayed only with difficulty. Towards the less consistent part, more numerous fusiform cells with oblong *nuclei* were visible, whose regular arrangement was rendered apparent on the addition of acetic acid. The nasal *polypus* was softer, consisted of larger cells, and presented wider reticulations. Some *polypi* of the stomach, as they are termed, about the size of a bean, projecting from the surface of the mucous membrane into the cavity, exhibited, even under a low magnifying power, and by reflected light, a trabecular tissue with several hemispherical prominences. The substance was constituted of straight fibres arranged so as to form a wide meshwork, containing in the spacious interstices, granular corpuscles, usually of an elliptical form, but some more or less angular, together with fusiform cells, with one or two good-sized *nuclei*. The pepsin-glands, in these situations, no longer existed. We regard this growth, also, as a new formation of connective tissue, arising from the connective tissue *stroma* of the membrane, supplanting the glandular follicles, and still retaining the epithelial coat. What is termed "hypertrophy *of the membranes of the stomach*, consists principally in a growth of fibrous connective tissue in the submucous *stratum*, to which is occasionally superadded a hypertrophy of the muscular substance, in the pyloric portion of the *viscus*.

§ 5. Uterus and Chorion.

The new-formations met with in these situations occur under two forms: 1. As distinctly circumscribed *tumours*, encysted either in the substance of the *uterus* and supported on a broad base, or projecting on a peduncle into the cavity of the organ, or of the *vagina*, or towards that of the *peritoneum*. 2. As *shaggy growths* thrown out upon the inner wall of the *uterus*. The formations of the former kind are usually termed *fibroid*, and when pedunculated, *polypi*.

A uterine *polypus* which was ligatured by Prof. Chiari, presented an oval form, and a pale-reddish colour; it was 2·34″ long, 1·17″ broad, and about 0·96″ thick, tolerably consistent, and at the same time somewhat extensible, exhibiting on one side of its surface, short, pale-red fibres, which, when removed by the forceps, appeared very closely to resemble those of organic muscle. They constituted bundles (fig. 99, *a*, *b*, *c*), decussating under various angles, and composed of long, straight elements attenuated at each end (*d*); which were arranged parallel to each other, and in this way formed band-like streaks. The *nuclei* were rendered more distinct by acetic acid. On the surface of a section, the *areolæ* were visible, like minute pits of different sizes; the largest of them appeared to the naked eye about the size of a pin's-head, and they were occasionally filled with coagulated blood. No trace of perfectly formed vessels could be detected. The constituent elements, which were obtained in small quantity by pressure, were mainly, pale, oval cells in scanty numbers, and fusiform corpuscles with slender *nuclei* pointed at each end. Lastly, there was also a considerable number of flattened, hyaline masses of indeterminate form and size, usually irregularly jagged at the edges (most probably colloid in the solid state). The bundles

Fig. 99.

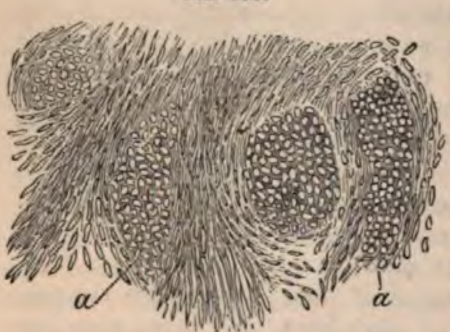


of connective tissue, which could be traced in thin sections, had a distinctly areolar arrangement, and decussated with each other at all angles. The various layers of slender, oblong *nuclei* were brought into view on the addition of acetic acid; but neither by that reagent, nor by carbonate of soda or potass could any elastic filaments be displayed.

As the operation had an unfortunate result, an opportunity was afforded of examining the substance of the *uterus* also: this organ was considerably thickened (up to 0·094″). On its inner aspect, corresponding to the place of attachment of the *polypus*, there was a depression, and the adjoining substance of the *uterus* was, there, more vascular than elsewhere. The fibrous tissue was infiltrated with a fatty, molecular material to such a degree, that, even to the naked eye, the whitish reticular streaks produced by the deposit were visible, not unlike the *reticulum* of cancer.

In order to obtain a more distinct view of the *grouping* of the elementary constituents in growths of this kind, it is advantageous to boil them in dilute acetic acid, and to take thin sections from them, when again dried. Fig. 100 represents a section prepared in this way. It was taken from a uterine *polypus* presenting the same characters as the one just described, and which had been removed by Prof. Chiari. The pointed *nuclei* are seen disposed, at regular distances apart, partly in directions parallel with their longitudinal axis, partly in a sort of areolated, divergent fashion. These systems of *nuclei* enclosed spaces (*a a*), exhibiting, at definite intervals, rounded, or perhaps also elongated corpuscles, representing the *nuclei*, seen under a right, or somewhat oblique angle, of fusiform cells disposed in a direction vertical to the foregoing. Thus, in this instance, there existed, essentially, two systems of fusiform cells crossing each other at a right angle.

Fig. 100.



The encysted fibroid tumours of the *uterus* not unfrequently present numerous nodules, varying in size from that of a lentil to that of the closed first. They are surrounded by a more or less dense sheath of connective tissue, in which are always lodged several considerable-sized vessels, and which may be regarded as the proper source of the nutrition and growth of the tumour. The consistence of these tumours is, usually, very dense. In the transverse section of a tuber of medium size, its composition of several lobe-like divisions may be observed even by the naked eye; the divisions are surrounded by a glistening, white, fibrous tissue supporting the vessels. These boundaries of the lobes arise from a fibrous structure, from which are formed secondary and tertiary subdivisions, which, when viewed by the microscope, are found to be ultimately composed of fibre-cells. Elliptical cells, also, are constantly met with, of small size, with a proportionately large *nucleus;* and short fusiform cells with an oval *nucleus;* both in small number. The addition of acetic acid, or, still better, of a weak solution of carbonate of soda or potass brings into view very delicate, isolated, elastic filaments, which frequently occur in large quantity; whilst in other cases, again, they appear to be wholly wanting. The blood-vessels, even the larger, have very thin walls, consisting of a single layer having imbedded in it elongated *nuclei,* disposed in the axis of the vessel; they frequently diminish in size very abruptly, and often exhibit protrusions. The transverse fibres which are occasionally brought into view in these vessels upon the application of acetic acid, constitute a layer of inconsiderable thickness. Bloody points, however, may also be seen, without any defined line of demarcation, and with irregular, jagged processes. They occur altogether isolated, and have no sort of connexion with the blood-vessels. We are of opinion, that a new-formation of blood takes place at these points, which is at first unaccompanied with the development of any proper walls.

Fibroid tumours of the *uterus* very frequently undergo a *partial involution.* This change consists in the accumulation of minute fat-globules, unalterable by acids and alkalies, and composed of a brownish-yellow, or blackish-brown material. Very often, also, deposits of calcareous salts take place, sometimes in a fine-granular, sometimes in a botryoidal form, dis-

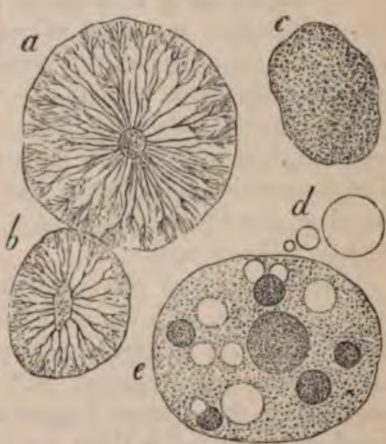
appearing on the addition of acetic or hydrochloric acid, occasionally with the evolution of air-bubbles. When the cretification is more extensive, small concretions are formed, which are readily enucleated from the closely applied capsule composed of connective tissue, and exhibiting, in thin sections, black, irregular subdivisions of various sizes, and usually jagged at the borders; these concretions are generally imbedded in a transparent, often streaked and granular interstitial substance, and might, on occasion, be confounded with bone-corpuscles. The distinction between the two cannot be more definitely stated until we come to speak of new-formations of bone, when we shall adduce an instance of a fibroid growth in the uterus, in which true ossification had taken place.

The looser, softer and redder new-formations of connective tissue, sometimes pedunculated, sometimes sessile, seated on the surface of the uterine cavity, or of the uterine canal, exhibit a more embryonic character. Their cells are larger, and present a greater multiplicity of form than do those of the dense, tuberous, fibroid growths. The clear vesicles which frequently occur on the surface or in their substance, contain a transparent, tenacious, glutinous juice, which is rendered opaque by acetic acid. Those parts which are of a lively red colour contain an abundance of vessels. Even by means of a simple lens, a very delicate vascular plexus may be seen, constituted of wavy, much convoluted vessels, assembled into lobate groups. As they ramify, the vessels diminish rather rapidly in size, forming open loops at the periphery of the lobes, resembling those represented in fig. 98, as occurring in the so-termed urethral caruncles. Besides this, on the surface of sections, tolerably extensive bloody spots may be seen, with respect to which it is still very doubtful whether they should in all cases be regarded as extravasations; at any rate, in some of these spots nothing but recent blood, without any indication of involution, can be perceived. The new-formations, which have a spongy feel, and present an indistinct fluctuation, enclose, between the lobules, fissure-like spaces, sometimes of considerable size, filled with a serous fluid. Solitary, or aggregated fat-cells, are occasionally met with in the parenchyma of these tumours.

A tumour, about as big as a hazel-nut, and of a lively-red

colour, was seated, with a broad basis, on the inner wall of the *uterus;* it was of soft consistence, and constituted of several, hemispherical, projecting lobules or nodules of various dimensions, filled with a transparent substance, and on whose surface very delicate vessels ramified. The main constituent of these nodules appeared to be irregularly shaped, pale, flattened, structureless corpuscles, some, also, being of an elliptical or oval figure, and which were unaffected by acetic acid. We think they must be regarded as colloid masses. In one of these lobules there was a considerable number of very curiously constructed corpuscles. Most of them were of a flattened, oval shape (fig. 101, *a*, *b*), whose outlines were occasionally indistinct. And they differed so widely in size that the largest specimens were at least from eight to ten times as large as the smallest, which scarcely exceeded an epidermis-cell in size. In the centre they presented a granular mass, bounded sometimes by a round, sometimes by a more elongated line of demarcation. From this mass, again, apparent filaments radiated, which bifurcated in their course, and when approaching the periphery broke up into a penicillar *fasciculus.* The terminal twigs belonging to one body sometimes encroached upon the limits of another, in which way were produced compound forms. In many other nodules which were examined, these bodies could not be found, but, instead of them, were seen elliptical, or oval, sharply defined corpuscles, containing a fine-granular material (*c*), and of various dimensions; hyaline structureless globules (*d*) of various sizes were, also, met with. The latter, as well as the granular corpuscles, were imbedded in a flattened granular body (*e*), or perhaps merely rested upon it.

FIG. 101.



Now what is the nature of these bodies, none of which,

perhaps, can be regarded as cells? It appears to us most probable that *a*, *b*, are colloid corpuscles, in which the centrifugal solidification has taken the filamentary form; that *e* represents a precipitated albuminous substance; and *d*, protein-masses in a semi-fluid condition. Repeated observations are required to elucidate these points more clearly.

The so-termed *ovula Nabothi* are usually regarded as distended follicles of the mucous membrane of the *cervix uteri*. But the general correctness of this opinion appears to be still very doubtful. The *ovula* are vesicular projections, of the size of a pin's head up to that of a pea, seated either on or in the mucous membrane; in the latter case sinking more deeply into the parenchyma of the *uterus*. They contain embryonic elements of connective tissue of the most various forms, imbedded in a clear substance. The cells occasionally attain to a gigantic size, and present two or three *nuclei*; their contents sometimes exhibit minute, black pigment-molecules. Pus-corpuscles, nucleated bodies, streaky masses (mucin), are found in them as well as in the transparent *mucus* (*vid.* fig. 76). Vesicular projections, exactly like the *ovula Nabothi*, are also found on the lips of the *os uteri*, where *papillæ* only and no mucous follicles exist.

Practitioners have often sent us organized bodies discharged from the *uterus*, with the question, whether anything like the structure of the *chorion* could be seen in them. They have usually been pale coloured, soft, and readily torn asunder by needles into fine fibrous fragments; but no *chorion-villus* has ever been perceived in them, nothing being apparent but much divided connective-tissue-bundles and cells of various forms.

A woman, at the climacteric period of life, and suffering from uterine hemorrhage, discharged an oval, soft, fleshy-red body, about as large as an *ovum* at six weeks. Not a single *villus* could be observed with certainty, although the thickness of the connective-tissue-bundles, and their divisions, resembled in some degree the structure of the peduncles of *villi*; a multitude of minute connective-tissue-cells, however, of an elliptical, oval, or fusiform shape, could be seen. Now, in this case, a decision was to be made between two possibilities, whether this body were *ab origine* a new-formation of connective tissue, or a *chorion* in progress of degradation into that tissue? As no vestige of a

cavity for the reception of the *ovum* could be perceived, and as, a few days afterwards, the same woman discharged a soft, fatty mass, mixed with *coagula,* which proved to be composed of connective tissue, and in which blood was likewise contained in cysts of connective tissue, without any other trace of vascularity, we regard it as more probable that we had to do, not with an aborted *ovum,* but with a genuine new-formation of connective tissue, which had been seated on the wall of the uterus, and been thrown off by the subsequent hemorrhage. [A very similar case, in which the mole was putrid, and, therefore, more difficult of examination, but in which no trace of villi could be perceived, is also given.]

But this much is certain, that new-formations of connective tissue not unfrequently occur on the wall of the *uterus,* in the form of *flocculi,* and become detached, in consequence of hemorrhage, suppuration, putrefaction, or repeated exudations.

In puerperal *endometritis,* we have also found, at the *place corresponding to the insertion of the placenta,* together with a great number of pus- and granular corpuscles, large, elliptical, oval, pyramidal, rhomboidal or fusiform cells. The *nuclei* were comparatively very large and oval, and the *nucleolus* very distinct. The *nucleus* was excentric, drawn out, and narrow in the more slender fibre-cells, and often double. The cell-contents were usually finely molecular, but occasionally, also, groups of fat-granules might be observed in the larger cells. The latter, with their manifold transitional forms, which, by the way, it may be remarked, presented all the characters of what have erroneously been described as the specific cells of *cancer,* could only be regarded as new-formed connective-tissue-cells.

It has already been remarked, in speaking of the serous degeneration of the *villi* of the *chorion,* that large, embryonic, connective-tissue-cells occur, which escape in considerable abundance when the *chorion* of *ova* in the first months of pregnancy is torn asunder (*vid.* fig. 32, *c*). These cells may be placed in three categories: 1. Spherical forms (*vid. c,* the uppermost row of cells); among which, the cells, presenting a hyaline space, occupying nearly their whole interior, may be variously interpreted. For the question arises, whether the spherical, light space which, in its excentric position, is sur-

rounded by a finely granular substance, represent a *nucleus*. Should it be so viewed, the latter might be regarded as in a state of serous degeneration. But the possibility may exist, that in the serous degeneration of the *plasma*, water is imbibed, and forces the molecular contents towards one side. But the circumstance, that the light space is so distinctly bounded and spherical, and the fact, that if of smaller size it would necessarily be looked upon as a vesicular *nucleus*, render it far more probable that, in the dilated condition, it still represents a body of that kind. 2. The cells of an oval form also have an oval, hyaline *nucleus*, which is partly concealed by the more abundant, granular cell-contents. 3. Cells with one, two, or several, pointed processes, still always presenting the large, pale *nucleus*.

In a case of *mola hydatidosa*, which occurred in the practice of Professor Klein, it was manifest that the essential character of the growth consisted in an embryonic new-formation of connective tissue, combined with a serous degeneration of the *villi* of the *chorion*. In this case, the vesicular mole constituted a light, flocculent, racemose mass, about the size of a child's head, and weighing one pound, and composed of innumerable, clear vesicles, varying in size from that of a hempseed to that of a pea, and connected into filamentous strings. In the central substance of the mole we noticed a sacculated, softer, gelatinous portion, faintly tinged with blood, and about an inch long, at the inner side of the periphery of which a short, filamentary body (remains of the embryo?) depended, whilst externally a collapsed vesicle (umbilical vesicle?) was placed. These supposed structures could not be subjected to any closer examination. Besides the *villi* in a state of fatty and of serous degeneration (fig. 32, *d*), the thin, clear, gelatinous, viscous masses, collected for the most part in the *villi*, transformed into vesicles of divers shapes, but partly also in the substance of the peduncles of the *villi*, attracted our attention. They contained scattered, embryonic connective-tissue-elements of the most various dimensions and forms, and irregular traces of straight filaments, closely resembling those described as *mucin-filaments*.

In the distended *villi* of a fresh *mola hydatidosa*, Virchow found a substance which he distinguishes from fully developed

connective tissue, as well as from colloid, by their different chemical properties, and describes as "*mucus-tissue.*" He has pointed out the existence of this tissue in the umbilical cord, the vitreous body, and in a whole series of pathological formations, which have hitherto been referred to colloid tumours (as, for instance, gelatinous cancer).

Embryonic formations of connective tissue, in various stages of development, may almost always be observed on the concave surface of the *placenta* of still-born or aborted *fœtuses* in the last months of pregnancy (*vid.* figs. 77 and 78). On the convex surface, and in the parenchyma of the *placenta*, these new-formations are seen in the form of minute nodules, and in cases of adherent *placenta* they form connecting bands between it and the uterus. Dr. Braun records an instance of a very diffuse new-formation of connective tissue in the *chorion* of a woman affected with *syphilis*. The growth was of very lax consistence, discoloured, and without any clearly defined *villi*. The substance had degenerated into a molecular mass, with angular *nuclei*, which were so abundant as to produce an evident cloudiness in the water used to wash the preparation. Numerous, large, flattened, mostly elongated cells, with a transparent *nucleus*, and abundant fatty molecules in their contents, were also met with, assembled into considerable groups. We consider this instance as so far remarkable that new-formations of connective tissue are, in general, frequent in syphilitic cases, and in the present instance had induced an atrophy of the parenchyma of the *chorion*, which, again, had caused the abortion of the embryo.

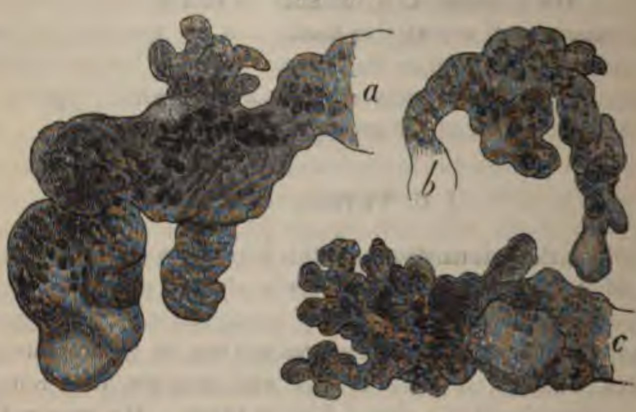
§ 6. Thyroid gland.

Well-marked formations of this kind occur in that class of cases of bronchocele known as *cystic struma*, and described by Rokitansky as the second type of bronchocele. The organ is misshapen, and its surface rendered uneven, or tuberculated, by elevated nodules, of various size and number, of a rounded form, and enclosed in a dense, fibrous tunic. We have noticed the latter in speaking of exudations limited to separate portions of the thyroid body, and, at the same time, adduced the fact, that a new-formation of connective tissue takes place

around the infiltrated lobules, followed by an increase in the number of vessels also. The more or less vascular connective-tissue-capsule now becomes, as it were, a fresh *nidus*, from which a new organization commences in the *plasma* which is continually deposited on its inner surface.

The encysted portion of *parenchyma* of the gland, in most cases, is then wholly or partially removed, nothing remaining but a sac, filled with a more or less thin fluid, and lined with an *epithelium*, and which thus presents the properties of a cyst. Now, if the inner surface of this cyst be subjected to a closer examination, there will, in many cases, be perceived, even with the naked eye, short, fringe-like projections, which float out under the water, and are, apparently, affixed to the inner wall by a pedicle. Occasionally, these processes are not visible until the blood-coagula, not unfrequently collected in the sac, have been carefully washed away. This was the case in the instance here represented, in which the fringes projected beyond the centre of a cyst nearly an inch in diameter, and, when cut off at their insertion, presented the following appearances: they were supported on a peduncle, which was elongated into a stem, dividing and subdividing into primary and secondary branches (fig. 102). The stems and branches

Fig. 102.



were sometimes slender and weak, sometimes thicker, and beset with several nodular protrusions (*a*). The terminal branches appeared rounded, assuming the form of hemispherical, cylin-

drical, conical, or clavate *papillæ*. They were seated either in groups, or solitary upon a branch, or as wart-like elevations immediately upon the stem. The hemispherical, papillary excrescences which must be regarded as the most recently formed, were seated in great numbers upon the stem seen arising at *a*. All the excrescences in this instance were of either a darker or lighter brownish-red, and brownish-yellow colour, and, under stronger magnifying powers, presented a distinct contour line throughout the periphery.

Their *structure* may be deduced from those amongst them which had undergone little or no degeneration. On their surface was occasionally apparent, an epithelial investiture, consisting of minute, polygonal cells, almost entirely filled with an oval *nucleus*, which, where fatty degeneration had commenced, was seen to be surrounded with a circle of fatty molecules. In those which had no *epithelium*, the addition of carbonate of soda, nevertheless, still brought into view the *membrana propria* as a sharply defined, light-coloured border. The proper parenchyma was constituted of coalesced connective-tissue-elements, with elongated *nuclei*, which became transformed into connective-tissue-fibres. Rokitansky, who first noticed these dendritic excrescences of the cyst, regards them as hollow structures, and describes them as containing very considerable vessels, forming large loops and curves. It is highly probable that Ecker's vascular bronchocele, presenting aneurismal dilatations of the new-formed vessels, depends upon a more luxuriant vegetation of the vascular excrescences, and should hardly be regarded, as Rokitansky has already remarked, as a distinct species of bronchocele.

The *development* of these growths may be observed on the inner wall of the cyst. Small, hemispherical, sharply-defined projections arise from the deposition of the plasma in circumscribed spots; their contents are at first fine-molecular and opaque, afterwards becoming transparent, and presenting lighter, nuclear bodies. As the excrescence increases in length, rounded protuberances are visible upon it, which, continuing to grow, become branches, and again, as it were, push out new buds. These new-formations, however, undergo a *retrograde metamorphosis*, sometimes partial, sometimes universal. Their contents degenerate into a fatty, molecular substance, which collects,

especially at the apices of the *papillæ*, is unaltered on the addition of acetic acid and of the alkaline carbonates, and appears dark-grey by transmitted, and white by direct light. By the accumulation of colouring matter the excrescences are rendered brownish-yellow and reddish-brown. They sometimes acquire a sandy feel, from the deposition of calcareous salts in a granular form.

Rokitansky first ascertained that, in consequence of the increase of the new-formed material in the cyst, the latter at length exhibits a curious conformation, presenting the appearance of transparent, irregular, hollow structures, either lined with a layer of *nuclei* like an *epithelium*, or bare, and containing in their cavity, besides free *nuclei*, the *glandular vesicles of the parenchyma of the thyroid gland*, in the most various stages of development. But under these circumstances it is difficult to determine, whether the vesicular bodies are fully developed or partially devéloped thyroid vesicles, or distended *areolæ* furnished with an *epithelium* (like cysts). The structure of the normal glandular vesicles of the thyroid is described by Kölliker as consisting of a perfectly homogeneous, closed, clear, and delicate *membrana propria*, lined by an *epithelium*, and filled with fluid contents. Starting from this point of view, we have pursued our researches.

In thin sections of the lax, new-formed tissue, which are readily made by means of the scissors, it is satisfactorily shown that the *matrix* is formed of slender, arched fibrils, whose numerous subdivisions constitute a delicate network. Within these reticulations is visible an *epithelium*, composed of flattened, delicate, light-coloured cells, furnished with a rounded, granular *nucleus* (fig. 103, *A*, in the space *a*). Closer observation will show the existence of a subjacent layer of epithelial cells, which, for the sake of distinctness, have been left dark; the very delicate, filamentous bundles of connective tissue stretching over the *epithelium* are not represented, that the clearness of the figure might not be interfered with. The *areolæ* lined with *epithelium* are of the most various dimensions and forms—rounded (*e*), oval (*a*, *c*), subdivided into two or more compartments by projecting ridges of connective-tissue-bundles (*b*, *d*), elongated (*f*), &c.

The epithelial cells differ according to the stage of evolution or involution in which they may happen to be. In many, the

nucleus is wanting; and between the cells (consequently in the intercellular substance), a finer (*d*) or coarser (*e*) molecular

FIG. 103.

substance may be perceived surrounding them, and which is to be regarded as indicative of a fatty degeneration of the intercellular fluid.

The proper contents of the *areolæ* is a transparent fluid or solid material, which, when in the latter condition, readily escapes from the *areolæ*, when they are ruptured, and exhibits the most varied outlines. We have represented some of these in fig. 103, *B*. These masses, as has been stated before, under the head of "Exudations," are flattened, round, oval, reniform, elongated, puckered, furnished with cuneiform processes, &c., never present any cell-wall or nucleus, and are, consequently, structureless; in acetic acid they either undergo no change, or, at most, assume a very finely granular, yellowish appearance towards the centre. We do not agree with Rokitansky in believing them to be vesicles, as they are manifestly without the investing membrane; in our opinion they are merely solidified colloid masses, which, in their form, partially assume that of the *areola*

containing them, and have no original connexion with the problematic glandular vesicles. Like other viscid fluid matters, they necessarily solidify from the periphery towards the centre, and it is highly probable that the concentric layers are produced by a periodical solidification, just as, in consequence of a fatty degeneration of the fluid central matter, a collection of fatty granules is frequently seen in the elliptical forms.

With the colloid-corpuscles, portions of *epithelium* (*g*) always escape in the dissection, often curling over at the edges. Occasionally, delicate vessels may be observed accompanying the connective-tissue-bundles, which, as at *h*, not unfrequently contain a considerable number of white blood-corpuscles.

For the further understanding of the structure of the new-formed tissue in the cysts, the very delicate, pale, transparent parts are serviceable. They exhibit, within the investing connective tissue of the *areola*, oblong *nuclei* (fig. 104, *a*), lying with their long axis parallel to the course of the fibres. The epithelial cells are uncommonly delicate, and are found even in the most minute *areolæ* (*b*), which do not enclose more than three or four of them. The lace-work (*c*), composed of very slender bundles, surrounding the *areolæ*, lined with *epithelium*, may be observed more readily, from its areolar arrangement.

Fig. 104.

The involution of the tissues within the cyst is manifested, by their white aspect, diminished transparency, and dirty-yellow or yellowish-brown colour. The *epithelium*, from the stage of fatty degeneration indicated above, passes into one so advanced, that nothing is left of it but a granular matter unaltered in acids and alkalies. Sometimes, also, the change proceeds to the deposition of earthy salts in the granular form, which dissolve in hydrochloric or acetic acid, with the copious

evolution of air-bubbles. The connective tissue is covered with fatty molecules, or calcareous particles, or is rendered wholly unrecognizable in consequence of its infiltration with colouring matter. The blood-vessels appear more or less closely beset with fatty granules (*d*), or incrusted with calcareous salts, which can be removed by the above acids; or the transparency of the vessel and of its branches is so far diminished by the presence of a material composed of fatty and colouring matter, that it is brought to resemble an opaque streak (*e*), white when viewed by direct light. Besides vessels in this condition, granule-masses, of an oval or rounded form, are often met with, or irregular groups of fatty molecules. Orange-coloured pigment (*f*), in the form of coarse granules, disposed in elongated rows, or aggregated into little masses, may also assume a dark brownish-red or black colour (*f* at +). This colouring matter is always present in large quantity when the new-formation is of a brownish-red hue, and it may be produced in various ways. For the pigment-granules may arise from the cohesion of the shrunken blood-corpuscles—from the imbibition of the fatty molecules with colouring matter—or, directly, from the precipitation of the dissolved *hematin*. It has already been remarked, when we were speaking of atrophy of the blood, that the interesting metamorphoses of the red blood-corpuscles, first described and figured by Virchow, may be sought for in the red-brown deposit of these cysts.

We think that we have shown in the preceding observations: 1, that the connective-tissue-bundles are disposed in an areolar manner; 2, that the *areolæ* thus formed, lined with *epithelium*, are, frequently, not round and vesicular, but constricted by projecting ridges of connective tissue, whence they assume an elongated form; 3, that it is probable, that the epithelial investment is continued from one *areola* into another. We must be allowed, therefore, at present, to doubt the glandular nature of these *areolæ*, since, as stated above, the vesicles of the thyroid gland are completely closed and spherical. On the other hand, it must be allowed, that an unmistakeable similarity exists between the new-formed tissue in the cysts and the neighbouring parenchyma of the thyroid body; with respect to which, however, it must be remembered, that the latter is placed in abnormal conditions. But the possibility still re-

mains to be discussed, whether this new-formation may not depend upon a persistence of the *embryonic stage in the development of the thyroid gland*, in which the vesicles have not yet become completely closed. This latter view would be in accord with Kölliker's conjecture, that the vesicles, during the fœtal period, multiply by the protrusion of rounded buds, and their *constriction*, and would thence seem to have a considerable amount of probability in its favour.

The tissue contained in the cyst occasionally presents conditions wholly analogous with those represented in fig. 53. The embryonic glandular vesicles have in great measure been destroyed by the accumulation of a fluid containing colloid, nothing remaining but cysts, often without any epithelial lining. The enclosed tissue, moreover, may undergo such a degree of involution, that nothing is left of it but a dirty greyish-red pultaceous matter, indistinct nuclear bodies, very numerous cholesterin-plates, and dirty brownish-yellow and brownish-red, irregular, flattened corpuscles of various dimensions, without a trace of any other organic structure (colloid impregnated with hematin ?).

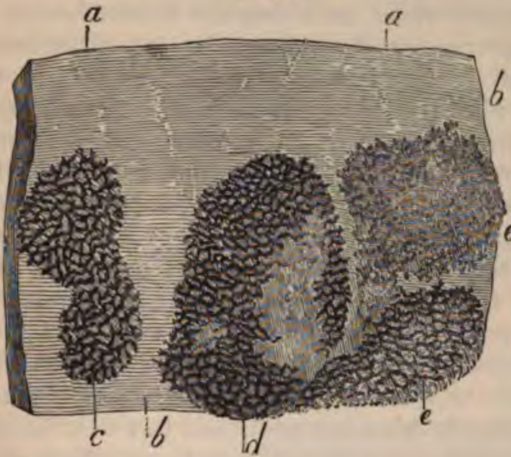
§ 7. Liver.

In this organ the new-formations of connective tissue appear in the *diffuse* and in the *concrete* form, that is to say, involving a considerable space in a uniform manner, or limited to more circumscribed spots in the form of nodules. The former kind is seen, especially, in the *granular liver* (*cirrhosis*, Laennec). In this case the new-formation arises, without doubt, from the connective tissue accompanying the larger vessels into the lobules, and which is known under the name of the capsule of Glisson. The excessive hypertrophy of this tissue destroys the proper parenchyma—the hepatic cells—and induces a secondary atrophy of the organ, which, in many parts, may proceed so far that nothing remains but a callous, tuberculated, cicatriform tissue.

Thin sections, which, in this case, are best made with the double-bladed knife, show an increase of the connective tissue, and a diminution of the proper hepatic substance. In fig. 105, *a a* represent the surface of the liver, the substance indi-

cated by straight lines (*b b*) the connective tissue, and the darker insulated spots (*c*, *d*, *e e*) represent the remains of the

Fig. 105.



hepatic lobules, in various stages of involution. The botryoidal surface of the liver of a man affected with dropsy and jaundice, presented a multitude of isolated, darkish spots of various sizes and colours, which, in many situations, were distinctly apparent only at some depth from the surface, and, in the section, corresponded to the insulated spaces. The divided lobule (*c*) presented a blackish-brown network, precisely resembling the portal capillary plexus; in *d*, this network was interrupted by several lighter-coloured spaces. The lobules (*e e*) appeared of a deep yellow, and in them the coloured plexus was not so distinctly evident.

The minute investigation showed that, although some of the pigment-molecules might be lodged in the hepatic cells, the greater part of them lay in the intercellular substance. The pigment exhibited very numerous shades of colour, from blackish-brown to red-brown, orange and gold yellow, all of which could frequently be observed in one and the same lobule, whose peripheral portion, for instance, might be darker, and the central more lightly tinged. The hepatic cells, in many places, appeared to be in a normal condition, whilst, in others, they were in a state of incipient fatty degeneration. In the thick tracts of connective tissue, which occasionally

accompanied the larger vessels in a half-obliterated condition, abundant fat-globules and scattered pigment-molecules were imbedded. In those situations where the connective tissue had as yet undergone no retrograde metamorphosis, that is, no fatty or pigmented degeneration, an abundance of developmental forms of that tissue, principally fusiform fibre-cells of various widths, with an oval or more elongated *nucleus*, and flattened cells, with 1—3—4 processes, and of divers shapes, was displayed. So that, perhaps, no doubt could be entertained with respect to the actual occurrence of a new-formation of connective tissue; and no ground existed upon which the objection could be entertained that the hypertrophy of the capsule of Glisson was only apparent, inasmuch as the proper glandular parenchyma was in a state of atrophy.

The various shades of colour observed in the leathery, tough, dry hepatic substance, yielding comparatively but a small quantity of pulp when squeezed, and to which, in addition to the colours above enumerated, a leek- or olive-green may be noticed, are manifested more distinctly in those granular livers which are accompanied with jaundice. This condition seems to be brought about by the new-formation of connective tissue, which, advancing along the course of the vessels, and consequently of the biliary ducts also, causes an obliteration of the latter. Injections of the various sets of vessels would be most desirable in these cases, in order to ascertain: 1, to what extent a partial close of the biliary ducts, or (2) a partial obliteration of the branches of the portal vein and hepatic arteries, takes place; or (3) whether the capillary system of the portal vein remain open to some extent, and (4) whether any kind of collateral circulation be established. It is evident that the coriaceous, tough, dry portions of tissue, a section of which is represented in fig. 105, no longer transmit any blood; the dark-coloured networks of the atrophied lobes (*c*, *d*) are derived, for the most part, from necrosed blood of the portal capillary *plexus*, whilst the more uniform coloration of the groups of hepatic lobules is referrible to the various changes undergone by the colouring matter of the bile. The hepatic cells, also, contain a considerable quantity of mostly ochraceous pigment-granules, exhibiting various changes of colour on the application of nitric acid.

The incipient granular liver, so far as concerns its outward aspect, might be confounded with the nutmeg-liver (*vid.* fig. 28). In both may be observed, even with the naked eye, a yellowish and a brownish-red substance. The mutual relations of these two substances will be rendered clear in the surface of a section, viewed with a lens (fig. 106, *b*). The lobate spaces left of a light colour, correspond to the yellowish-white substance, and the interposed dark portions to the brownish-red. The light colour depends, in some degree, upon the presence of fat, and partly upon the deficiency of blood in the lobules, whilst the brownish-red substance owes its colour partly to the blood contained in it, and partly to the presence of pigment. The large veins, cut across in sections, either transverse or oblique, appear as streaks or points, in both the white and in the red substances. The elementary analysis of the latter, in the incipient stages of granular liver, will, necessarily, always bring into view numerous fusiform cells, since, were this not the case, it could be described merely as being in some state or other of involution.

Fig. 106.

In the case here represented, there also existed a remarkable complication; the surface of the liver exhibited *erosions*, that is to say, level, shallow, excavations, like ulcers. The smallest, scarcely visible by the naked eye, were sometimes rounded, elongated or constituted of several irregular prolongations. The larger often presented in the middle of the floor a ramifying blood-vessel, which lay exposed in the yellowish-brown hepatic substance; the peritoneal coat was wanting in all these erosions. Their existence, we think, must be referred to the occurrence of an exudative process in the peripheral lobules. The peritoneal coat would be destroyed by the subjacent exudation, and the hepatic substance, with its vessels, thus be

exposed. The sinuated figure of the border would, consequently, be due to the exudation following the disposition of the lobules. Lastly, we may add, that these erosions have, only once, occurred to our observation.

The new-formation of connective tissue may, probably, originate in a *plasma,* afforded by the ramifications of the hepatic artery, whose terminal branches, as is well known, embrace the groups of hepatic cells, and provide for the nutrition of the organ, whilst the portal capillary plexus effects the secretion of the bile. Now, since the new-formation in many places may be observed very distinctly surrounding the groups of lobules in the form of a light-coloured, tolerably wide border, the opinion above expressed would appear to have some foundation.

Dittrich has shown that, after inveterate *syphilis,* the liver frequently presents a cicatriform tissue on its surface, which may extend deeply into the *parenchyma.* We have also noticed irregular, scattered nodules, consisting, like the cicatriform contracted parts, of connective tissue. These parts are occasionally found in a state of involution, containing an abundance of minute fat-globules and free pigment-molecules, and, when torn asunder, also presenting shrivelled *nuclei.* In the neighbourhood of these fibroid nodules, where the hepatic substance has already lost its normal texture, irregular, clotted masses, in which no further organization has been set up, may be observed. The callous streaks, penetrating the substance of the liver, of a lightish-grey colour, consist of wavy fibrils, occasionally crossing each other (fig. 107), which, when treated with acetic acid, exhibit elongated, imbedded *nuclei,* placed at regular distances apart. Besides this, groups of pigment-molecules are very frequently seen, no longer contained in a cell (fig. 107, the upper part), whilst, in many other situations, they are still manifesty enclosed in a tunic (fig. 107, below).

Fig. 107.

A well-marked instance of the new-formation of connective tissue was presented in the liver of a new-born child, covered with *pemphigus*-vesicles. The

mother was affected with secondary syphilis. On the concave surface of the liver, there was a yellowish spot, scarcely raised above the surface, about the size of a bean, of a rounded form, and ill defined at the border, and which gradually assumed a brownish-yellow or liver-brown colour. The lighter coloured portion of the tissue extended to about 0·39″ in depth. The surface of a section was of the deepest yellow colour in the centre, and the consistence of the deposited substance in general, considerably denser than that of the surrounding hepatic *parenchyma;* the texture was irregularly granular; and on pressure, only a trifling quantity of turbid fluid could be obtained. The softer portions of the new-formation contained, principally, cells, of the most diverse forms (fig. 108), furnished with one, two, three, or four processes, and with one or two *nuclei,* of an oval form, with *nucleoli.* The *nuclei* were placed excentrically, and, when double, were frequently in close apposition, but occasionally, and more particularly, in the cells with a central constriction, they were situated at each end, at a considerable distance apart. The fusiform cells, of the most various widths, were usually arranged in obliquely ascending, parallel rows. The more consistent portions were constituted chiefly of fibrous bundles. The rest of the hepatic substance exhibited no striking anomalous condition. In one of the *cornua* of the thymus-gland in the same child, there was a central cavity, filled with a viscid, puriform fluid adherent to its walls, and containing mucin-filaments and pus-corpuscles (*vid.* p. 306, "pus in the thymus").

Fig. 108.

Professor Dittrich, who was accidentally present at the examination of the liver in this case, noticed a surprising resemblance between the appearances there presented, and those which he had discovered and described in the livers of adults affected with inveterate syphilis.

The most remarkable distinction, therefore, between the granular liver, and that affected as above, in cases of *syphilis,* consists mainly in the circumstance, that in the former, the new-formation appears in a diffuse, and, in the latter, in a concrete form, that is to say, is more limited to isolated

portions of the hepatic *parenchyma*. The process followed in the development of the new-formation is, of course, the same in both. But whether *syphilis* alone produce this concrete form may, perhaps, admit of considerable doubt.

After long-continued *intermittent fever*, the liver acquires a slate-grey colour, its texture is less distinctly recognizable, and its consistence somewhat increased. H. Meckel and Heschl have directed special attention to this structural change, and particularly adverted to the increased amount of pigment in the liver. The venous blood no longer presents the dark-red colour, and contains blackish-brown granules (fig. 109, *a*) of a rounded shape, and, some of them, somewhat exceeding the blood-corpuscles in size. They are, not unfrequently, agglomerated into little masses, or disposed serially in the hepatic capillaries (*a* + +), whose *lumen* is thus obstructed. These granules, also, may be so much diminished in size, as not to exceed that of the larger, angular pigment-molecules. They cannot, however, be regarded as fully formed pigment, since they immediately disappear under the action of potass or soda, though remaining unaffected by acetic acid. They possess, therefore, the properties which we have ascribed to *hematin*.

FIG. 109.

The hepatic cells sometimes present an unusual quantity of dark pigment-molecules, which are collected, especially towards one side of the cell (*b*), or may even occupy the whole of the interior. Cells, thus rendered quite opaque by the accumulation of pigment, always retain the polygonal shape, though they are considerably diminished in size. In livers of this kind, the cells are often found to be filled with large and numerous fat-globules. Occasionally, also, a considerable abundance of rounded (*c*) or shrivelled *nuclei*, probably the remains of the destroyed hepatic cells, is met with. Lastly, cells of new-formation occur, exhibiting all the transitionary forms of connective-tissue-cells, and sometimes containing

agglomerations of pigment-molecules (*d*), sometimes without any. Their predominant shape is the fusiform (*e*). Whether the new-formation of connective tissue demonstrable in the thickened capsule of Glisson, in the slate-coloured liver after intermittent fever, be a constant phenomenon, we cannot say, from the few instances we have had an opportunity of observing.

§ 8. Kidney.

The new-formations of connective tissue in the kidney are always associated with an atrophy of the corresponding renal substance, precisely as is the case everywhere; but a new-formation of connective tissue will not be observed in every atrophied kidney. The deposit usually takes place throughout a considerable portion of the organ, or is generally diffused; and Henle has rightly compared this degeneration of the kidney to *cirrhosis*, or granular degeneration of the liver. It occurs, as is well known, at that stage of Bright's disease which has been described as that of atrophy.

In the *surface of a section*, a grey, dry, tough tissue is at once apparent, occupying interstices in the more or less brown, renal *parenchyma*. This deposit is especially evident in the cortical substance, and in the interstices of the pyramids; it presents an areolated fibrous structure, with numerous, scattered fat-globules, and pigment-granules, together with fusiform and elliptical cells of connective tissue. The *tubuli uriniferi* in these situations have usually disappeared entirely, or, as well as the Malpighian tufts, are reduced to a stunted condition, in which their outlines can scarcely any longer be perceived. The clearest view of these conditions is afforded in thin sections of a kidney which has been boiled in dilute acetic acid, and then dried. In such preparations it is clear that the new-formation proceeds from the interstitial tissue between the *tubuli uriniferi*, or, in other words, that it is a hypertrophy of that tissue, just as in the granular liver the new-formation is seated in the capsule of Glisson (the interlobular connective tissue). Henle has also observed that the fibrous tissue is more apparent in the dense, lardaceous portions, whilst the yellowish parts abound more in fat, and that those of a slaty-

grey colour contain a dark pigment. According to Frerichs, in the atrophic stage of Bright's disease, a new-formation of connective tissue takes place in the exterior of, and within the capsules of the Malpighian bodies. But he expressly remarks, that a hypertrophy of the interstitial connective tissue does not exist in every instance of this atrophy.

The new-formation may occasionally be traced to the *surface of the kidney*, where it produces callous, cicatriform spots, depressed below the level of the surface; which spots present sometimes a close fibrillar structure, sometimes one composed of clotted masses, transparent in thin sections, and unaffected by acetic acid (colloid masses), which also occur in the lardaceous, dense portions within the substance of the gland. The botryoidal elevations seen on the surface, either with or without the cicatriform depressions, correspond, as was stated when we were speaking of atrophy of the kidney, to groups of *tubuli uriniferi* in a state of involution, of which various gradations may often be observed in one and the same specimen. The *tubuli* are filled with a fine-molecular fat, by which their transparency is destroyed; frequently present a brownish-yellow colour, derived from imbibed *hematin;* whilst the *glomeruli* are diminished in size, covered with pigment- and fat-molecules, and have obviously lost the power of transmitting the blood. Occasionally, round, encysted bodies, scarcely half the usual diameter of a *glomerulus*, are met with, filled with a dark, finely granular substance; these probably represent a degenerated form of the Malpighian tufts; but as we cannot discern a vestige of a convoluted vessel in them, the possibility still remains, that these bodies may be regarded as new-formed *areolæ* filled with degenerated contents.

The extension of the new-formation to the surface of the kidney frequently leads to an intimate adhesion of the substance of the gland with the capsule, so close, in fact, that the latter cannot be raised without injury to the former. But in such cases it must not be supposed that a new-formation of connective tissue always exists, since an exudation poured out from the capsule of the kidney may also produce similar adhesions, as may be seen in the *pia mater* (p. 277), where frequently, no new-formation can, histologically, be demonstrated.

The process followed in the development of the new-formation can only be supposed to consist in the effusion of a *plasma*, which is no longer sufficient for the nutrition of the organ, and from which the new-formation in question is at once produced. The vessels of the interstitial tissue, surrounding the *tubuli uriniferi* with a capillary plexus, and the capsules of the Malpighian bodies (if Frerichs' observation be correct that new connective tissue is formed without and within the capsules) might be viewed as the points whence the formation of the *blastema* originates.

The new-formation of connective tissue in the kidneys is often accompanied with the development of *cysts*, which are here of especial interest, and with respect to which the most various opinions have been entertained. It is a well-known fact, that atrophies usually advance from the peripheral vascular ramifications towards the central, since, in the natural involution of the organ, less nutritive matter is by degrees afforded to the peripheral parts; and that in disturbances of the circulation, and in exudations, those at the periphery in general precede those of the centre. This course is particularly manifest in atrophy of the kidneys, whether it be associated with a new-formation of connective tissue or not. In the latter case, it usually originates from the peripheral part of the organ, and, in a direct manner, constitutes the cicatriform depressions surrounding the elevated groups of *tubuli uriniferi*. Now if, in this situation, formations of *blastema* take place, more circumscribed to isolated points, following a more rapid course, and of a more fluid nature, the groups of *tubuli uriniferi*, enclosed by it from their base upward, are made to coalesce, and a hollow is produced, the size of which, as well as the number of hemispherical dilatations, is in proportion to that of the groups which have thus coalesced. The roof of the cavity is formed by the connective-tissue-capsule of the kidney, or by a delicate network of connective-tissue-fibres, remaining after the removal of the capsule. If one of these *peripheral cysts* be opened, which, as is sufficiently well known, are of various dimensions, and filled with various contents, it will always be found that the *bottom* is constituted of new-formations of connective tissue; this surface is sometimes trabecular, with sinuous protrusions, sometimes beset with a sort of nodosities, or *papillæ*, which

present the aspect of sharply defined bodies, and when viewed from above in their transverse diameter, exhibit at first sight some similarity to a Malpighian corpuscle enclosed in its capsule, though usually far less in size, and not possessing the same structure, since they contain sometimes merely a molecular substance, sometimes oval *nuclei*, and not the smallest trace of the remains of vessels. The inner surface of the cyst is lined with a delicate *epithelium*, the cells composing which are flattened, polygonal, very transparent, of various dimensions, often possessing a tolerable-sized oval *nucleus*, and disposed in a simple layer. At the bottom of the cysts, where the connective-tissue-formations project, the *epithelium* is wanting. The cells are occasionally in a state of incipient fatty degeneration, when the oval *nucleus* is seen surrounded with a circle of fatty molecules.

The clear contents of the cyst usually present opaque flocculi, consisting of detached *epithelium*. But when they are of greater consistence, colloid masses will be seen of various conformation, sometimes, indeed, in the shape of flattened, occasionally very small, highly transparent, rounded bodies, or furnished with sacciform elongations (fig. 110, *a, b*). They

Fig. 110.

are wholly structureless, and surrounded with a peripheral boundary line, which nearly disappears in water. They are not changed in acetic acid, nor in a weak solution of carbonate

of soda. The laminated or concentric colloid-masses (fig. 110, *h, i*) precisely resemble those which we have figured as occurring in the *prostate* (fig. 59); and they may, without doubt, be regarded as the remains of Malpighian bodies. The form which we have described as the radiating colloid-corpuscle is more rare (fig. 58); and they seem to occur in cysts of an older date, with dirty-yellowish brown contents.

In cystic kidneys, we have several times seen, together with a very striking hypertrophy of the interstitial connective tissue, and in fact within it, organic structures, which lay altogether free in the vacuities. The figure of these bodies was round, oval, elongated, constricted in the middle, or furnished with a shorter or longer process. They were distinctly bounded, and had molecular contents; in the smaller corpuscles the *nucleus* appeared single or double (fig. 110, *c*), or multiplied into three (*d*) or several (*e e e*), so that the whole was not unlike a cell with numerous *nuclei*. The same kind of nuclear bodies, arranged with some regularity, also existed in the processes (*f, g*). The corpuscles were imbedded in groups in the connective-tissue-substance, though not in every part; they could be isolated, presented no cell-membrane, but when treated with acetic acid were often seen to be surrounded with an annular layer of oblong *nuclei*. Now, can these bodies be regarded as parent-cells? We scarcely think so; their variable dimensions, and irregular form, seem to render it more probable that they belong to an entire group of cells multiplying by division, and which are developed in the *areolæ* of the connective tissue.

The formation of cells is frequently not arrived at in the latter tissue at all, nothing being presented in it beyond an accumulation of colloid masses, imbedded in the renal substance, and assuming the form of sinuated *plaques*, occasionally with fatty molecules arranged so as to form reticulations (*k*), and of rounded, yellowish, vesicles, often scarcely visible to the naked eye.

A new-formation of vessels is frequently seen in the walls of the cysts, which may give rise, on the one hand, to the deposition of black pigment in considerable quantity on the outer side of the cyst; and, on the other, to hemorrhages into the cavity, and the accumulation of a cherry-red, brown-red, or saffron-yellow, amorphous material (necrosed blood?).

Minute, for the most part isolated, pedunculated cysts are often noticed on the mucous membrane of the *pelvis of the kidney*. These cysts have a globular or clavate form, and project into the cavity with their rounded extremity; the latter is more transparent, and contains a limpid fluid enclosed in an irregular space. Fibres belonging to the mucous membrane may be traced on both sides as far as to the rounded end, where they bend round, forming arches. On the addition of acetic acid, imbedded, oblong *nuclei* may be perceived lying with their longer axis parallel with the fibres. Embryonic forms of connective tissue are readily afforded when the substance is torn asunder. Whenever the cyst is of rather larger size, blood-vessels become visible, distinguishable by the mode in which they multiply by lateral, infundibuliform elongations. The *epithelium*, constituted sometimes, of broad, sometimes, of oblong cells, with manifold intermediate forms, constitutes the outer investment, or that looking towards the interior of the *pelvis*. In the same situation Rokitansky has also noticed scalloped excrescences.[1]

[1] Rokitansky formerly broached the notion that the cysts in the kidney were consequent upon a degeneration of the Malpighian bodies, and were constituted by a metamorphosis of the cellular layer of the body into a serous sac, caused by the pressure exerted upon its capsule by the Malpighian body crammed full of inflammatory products, and thence enlarged. The capsule, in this metamorphosis, receiving the vessels of the *glomeruli* into its tissue, for the production of a new-secretion. To this Frerichs has objected, that frequently no exudation is observed in the capsules of the *glomeruli*, and that nevertheless cysts exist. According to the later cyst-theory of Rokitansky, the cyst would be developed from a *nucleus;* and the bodies described by us as rounded, structureless colloid masses (fig. 110, *a*), would be sterile cells (*nuclei* grown into clear, structureless cells); and those described as concentric colloid bodies (fig. 110, *h*, *i*) would arise from several cells being contained one within another, in a pill-box fashion, in consequence of an endogenous production. With respect to this, we think it needless to do more than refer to what has been said on the subject of new-formations of connective tissue in the thyroid body, and of exudations in the prostate, and in the General Part of this work.

Frerichs has again brought forward the old opinion as to the origin of renal cysts, and refers their production to a dilatation caused by an obstruction of the *tubuli uriniferi*, but without adducing any additional reasons in favour of this notion. Bruch also regards it as probable that the cysts arise from an obliteration, and dilatation both of the obliterated *tubuli* and of the capsules of the *glomeruli*. This dilatation, it is asserted, reaches a certain degree, when the proper, preformed wall of the cyst (glandular membrane) which had existed up to this time, dehisces,

§ 9. Bones.

The new-formations of connective tissue originate either in the *periosteum* or in the connective tissue contained in the *cancelli* of the spongy bones or of the extremities of the long bones. They appear especially on the *periosteum*, with or without a new formation of osseous substance, and may attain to a considerable bulk, and displace all the contiguous and superjacent organs. Those growths, which commence within the bone, penetrate it in various points, and in this way become apparent; they are rarely connected with a new-formation of bone. If the new-formations assume the form of a circumscribed tumour, they are termed *osteosarcoma,* and are sometimes gelatinous, transparent (gelatinous *sarcoma*) containing principally embryonic connective-tissue-elements, or solid with a predominant fibrous formation (fibrous *sarcoma,* fibroid, *steatoma*). If the new-formation of connective tissue reach that of cysts, we have what is termed *osteo-cysto-sarcoma.* We shall now proceed to illustrate the more intimate histological conditions, by cases.

Dr. Dittel extirpated from the *antrum Highmorianum,* a tumour of about the size of a small citron. It was seated on the inner surface of the *antrum,* and had encroached to such an extent upon the nasal cavity that it was necessary to remove a portion of the cartilaginous *septum.* The outer surface of the mass, looking towards the bone, was beset with a multitude of minute calcareous concretions so as, in that part, to feel quite gritty. A section of the tumour displayed a rounded, central cavity filled with a clear fluid, whose wall was lined with a tolerably thick *epithelium,* and felt smooth. The growth was pale, in many places about 0·39″ thick, and on section it appeared glistening, striated, and afforded on pressure

and the cyst is bounded only by the tissue of the organ itself. We have already admitted the possibility of the dilatation of a tubule, when in a state of infiltration; but this condition is wanting in by far the greater number of cystic kidneys. A dilatation of the *tubuli* in the latter is conceivable, only when an infiltration can be shown to exist at the same time. Nor are we any better able, in every cystic kidney, to observe a dilatation of the Malpighian capsules, and are therefore of opinion that all foundation for the establishment of a theory of the kind is wanting, or rather that it is not a theory at all, but simply a hypothesis.

only a trifling quantity of a slightly turbid juice. The principal constituent was minute oblong cells, enclosing, at their wider and more truncated part, an oval *nucleus* of comparatively large size, and resembling the cells of cylinder *epithelium*. Elliptical and fusiform cells occurred more scantily, and the connective-tissue-fibres were delicate. The superficial concretions exhibited, simply a granular substance, which upon the addition of acetic acid, disappeared with the evolution of air-bubbles. Only very fine blood-vessels could be seen, in the form of short streaks, whilst in other places diffuse, bloody spots might be observed.

A tumour, also removed from the *antrum*, by Professor Lorinser, of the size of a small bean, was pale, soft, and readily torn in the preparation. It afforded on pressure only a very small quantity of clear fluid. The elementary constituents were for the most part elliptical, with a sharply defined, and smooth, or a worse-defined border, varying in diameter between 0·0031—0·004‴, and usually beset with clear, brilliant molecules, unalterable in acetic acid, in greater or less abundance. In the somewhat larger, elliptical cells, from one to three *nuclei* could often be perceived. In many the fatty degeneration had advanced so far that they had become granule-cells. Caudate cells were met with in less number. There was no trace of earthy concretions. But it must not be forgotten that, owing to the softness of the growth, its extirpation might not have been quite complete.

These two sarcomatous growths obviously belonged to the category of *tumours composed of embryonic connective tissue*, and had originated in the periosteum of the *antrum*, which is intimately connected with the submucous connective tissue. In the former case, no advance was made beyond the mere deposition of calcareous salts, since the new-formation appeared to be incapable of taking on any higher grade of organization, and, in particular, the vascular system was far too little developed to enable it to attain to the development of bone.

A tumour of considerable bulk seated on the body of the superior *maxilla*, was tense, very consistent, moveable to a slight extent upon the bone, and it occurred in an individual having carious teeth, but otherwise, as it seemed, not suffering under any constitutional affection. The free surface, projecting

into the cavity of the mouth was covered with the mucous membrane. The surface of a section displayed a firm, dense, fibrous, dryish texture, and towards the base it contained calcareous granules. Thin sections could readily be procured from both the superficial and deeper parts, which showed that the tumour was principally composed of fibrous bundles decussating with each other under various angles, and enclosing narrow *areolæ*. The fibrous bundles disappeared on the addition of acetic acid, and oblong *nuclei* were then brought into view disposed in the same direction; by the same acid also, the amorphous, scattered calcareous particles were gradually dissolved, and in part with the evolution of air-bubbles. The connective-tissue-cells were of small size, some elliptical, fusiform, &c., and existed only in small number. No trace of osseous or cartilaginous substance could be perceived. The blood-vessels were straight, and only here and there visible, as distant, slender, red streaks.

It is almost superfluous to state that this tumour was a *fibrous connective-tissue-formation*, and might be termed fibrous *sarcoma*, *fibroid* or *steatoma*.

A tumour seated on the outer aspect of the upper jaw, between the first and second molars, presented a structure differing from the preceding. Its length was about 1·17″, its shape semi-oval, and it was seated on a broad base from which it projected about 0·39″ in height; its consistence was dense and colour pale. A perpendicular section, displayed, in the centre, a portion of osseous substance, which was compact at the base and towards the periphery of the tumour, divided into pointed teeth; this osseous growth was covered externally by a tissue, partly cartilaginous, partly gelatinous, and of a yellowish colour. The tumour had perforated the external integument, and in fact projected a little above it. On the outer surface numerous, symmetrically-disposed, bloody points were apparent, corresponding to groups of horizontal vascular loops; no epithelial covering could be perceived. Connective-tissue-cells in various transitional forms existed in considerable number, in the gelatinous portion. The fibrous bundles had an areolar arrangement, and were without any admixture of elastic filaments. In the superficial, softer part of the tumour, an indistinctly lobate division was visible; and in the deeper

parts, towards the bony substance, the distended *areolæ* appeared to be filled with very numerous, flattened cells. A very careful search was made close to the osseous spicules for cartilage-cells; nothing, however, could be seen but small, mostly oval cells, disposed symmetrically in the connective-tissue-bundles. We think these should be described as cartilage-cells, analogous to those which are met with at the periphery of the larger tendons (for instance of the *tendo-Achillis*). Thus the tumour presented an instance of a new-formation of connective tissue, with a tolerably well-developed, vascular system, and associated with a new-formation of cartilage and bone, the latter radiating from the surface of the upper jaw towards the outer side of the tumour.

Dr. Zsigmondy removed a tumour about the size of a small walnut from the head of the metacarpal bone of the fore finger, which had perforated the skin and was quite exposed, having no epidermic covering. The skin was destroyed in a space of about 0·78″ in diameter, the edges of the opening being abrupt. The growth, when a section of it was made, was of a light-brown colour, smooth, exhibited a lobular structure, and afforded on pressure only a trifling quantity of a yellowish clear juice. The mass could readily be traced into the substance of the bone. The elementary organs constituting it were small, and for the greater part, rounded, though a few were fusiform and furnished with two, short opposite processes; the *nucleus* filled the cell almost entirely; the connective-tissue-bundles were delicate and unaccompanied with any elastic filaments. Towards the bone, the growth had a whitish-yellow colour, and the connective-tissue-elements in that situation were extensively affected with fatty degeneration. The parts surrounding the articulation were wanting. The cells of the articular cartilage were, here and there, in a state of incipient fatty degeneration. Comparatively speaking, but few blood-vessels were met with. After maceration, the altered form of the head of the bone was manifest: it is represented as viewed from the volar aspect in fig. 111. The osseous substance between the articular surface and the

Fig. 111.

shaft of the bone, to the length of 0·78″ and breadth of 0·57″, was destroyed, as was also a portion of the articular surface (*c*). On the inferior surface of the *capitulum* there was a shallow excavation (*b*), where the growth had been attached, and whence several perforations of the bone commenced, so that nothing remained of it but some osseous bridges. At *a*, an isolated portion of bone projected like a process.

Tumours of this kind, composed of connective tissue, are termed *osteosarcoma*, and when containing numerous large blood-vessels—*osteoteleangiectases;* and they have, without doubt, often been confounded with *cancer*. The *principal characters* consist: 1, in their circumscribed, independent development, from definite parts of the bone; 2, in a sharply-defined removal of the corresponding osseous substance, of which not a vestige remains. This destruction of the bone may be deemed a process of solution caused by the formation of a *blastema*. The liquefied, ossific matter, may be either absorbed or be applied to the development of the new connective-tissue. The further characters of these growths are found, 3, in a similar, sharply defined limitation between them and the other contiguous parts affected by their growth—as the articular capsules, tendons, muscles and skin; 4, in a symmetrical development of the elementary organs, consisting in their uniform size and form; which latter becomes changed in consequence of the involution which is set up in many parts of the tumour; 5, in the intimate cohesion of the elementary organs, so that the surfaces of sections appear smooth, and by pressure only a small quantity of a clear or slightly turbid fluid escapes.

New-formations of greater extent (diffuse) also occur in the bones. The *cancelli* of the epiphyses of the long bones are especially the starting point whence the new-formation advances towards the articular cartilage, which, then yielding, in circumscribed spots, presents the ulcer-like erosions which were formerly regarded as so mysterious. Of several cases, we shall mention only one, in which the morbid process had probably ensued upon a previous fracture of the bone. The articular cartilage on the head of the *humerus* which had been fractured obliquely from without and above, downwards and inwards, was thinner than natural and had lost its opaline aspect, pre-

senting in several places a dirty-yellow colour and red stains from imbibition. The most striking appearances exhibited in it, were several rounded portions, surrounded with a jagged border, and in diameter about 0·18″, in which the cartilaginous layer was so far removed that they had the appearance of ulcers; the bottom of these excavations was reddened, spongy, and consisted of immature connective tissue with blood-vessels; in consequence of which it was obvious that the wearing away or *usure*, as it is termed, of the cartilage had been effected. The contents of the cartilage-cells were altered, brilliant, minute molecules being deposited around the *nuclei;* the intercellular substance appeared clouded, and in many places brownish-yellow or reddish-brown.

New-formations of connective tissue in the spongy parts of the *epiphyses* gradually cause the destruction of the osseous *trabeculæ,* and in this way cavities are produced filled with the spongy growth; the latter, sometimes also, presents a gelatinous aspect with bloody points and streaks disseminated throughout (commencement of the formation of vessels). The surrounding medullary substance, under these circumstances, is redder than natural. New-growths of this kind are not unfrequently accompanied with suppuration, very abundant in many parts of them, and when the growth, attended with this complication, approaches the articular cartilage, a partial or complete detachment of it ensues. The necrosed cartilage then undergoes the well-known changes. Separate portions of the bone also die, their organic connexions being destroyed by the suppuration; the morphological change, therefore, corresponds with that which has been described as taking place in the case of necrosed bone (*vid.* "Atrophy").

Together with the new-formation of connective tissue, that of bone also, frequently takes place. Those parts of the bones at which the synovial capsules are implanted, are more especially the seat of wart-like *osteophytes.* Thus are produced complex processes which have been explained in various ways, and which will be discussed more particularly under the head of "osseous new-formations."

That new-formations of connective tissue also take place in the shaft of the long bones, has been already stated when we spoke of the exudations in the interior of bones (*vid.* p. 235).

At the seat of fracture in bones, the new-formation of an osseous substance, having a less capacity for organization, is very incomplete, and the union of the two fragments is effected mainly by a firm connective tissue.

In a case of *osteomalacia*, under which a woman had suffered for two years, we found, in the greyish-red, liquefied *medulla* of the *femur*, very numerous rounded cells (fig. 112, *a*), of various sizes (from 0·0039‴ up to 0·0047‴) with fine-molecular contents; the *nuclei* were large and varied in diameter; the largest measuring as much as 0·043‴, and the various forms presented by them could be better studied after the application of acetic acid. They were constricted in the middle, reniform, single or double, and not unfrequently two *nuclei* were connected by a slender bridge; the *nucleolus* was single or double (*b*). The cells constituted the principal elements in the *medulla*, and had replaced the fat-cells, which were mostly isolated and in a state of atrophy.

Fig. 112.

For the sake of comparison we have represented (fig. 112, *c*) the new-formed cells met with in great abundance in a rib affected with *osteomalacia*. The bone was taken from a woman who had laboured under cancerous deposits in the *uterus*, liver, and lungs; the bone-medulla in the affected part was of a dirty greyish-red colour, greasy and liquefied. The round cells, some of which were twice as large or more than others, contained a colossal, vesicular, light-coloured *nucleus*, which nearly filled them, and was without a trace of a *nucleolus*; the cell-contents were finely granular. Now what is the nature of the cells *a*, *b*, *c*? In the hyperæmic, reddish *medulla* of the articular ends of the long bones, Hasse and Kölliker have described minute, rounded, nucleated cells, whose pathological nature has been denied by the latter author, who recognizes in them a normal constituent of the "red, or even of the merely reddish *medulla*;" assigning to them the name of marrow-cells.[1] If these be compared with the cells *a*, *b*, we shall observe,

[1] ['Manual of Human Hist.,' (Eng. Transl.), vol. i, pp. 309-311.—Ed.]

disregarding the size and manifold forms of the *nucleus* in the latter, a great similarity to exist between them. In this sense, consequently, the present case affords an instance of an *excessive formation of marrow-cells*. But if we lay greater stress upon the different sizes, and particularly upon the diversity of shape of the *nuclei* in the cells *a, b*, we must assign a different character to them. Were they to be explained as being *embryonic connective-tissue*-cells, it would be necessary to conclude that the development of the derivative forms had not in the present instance been attained to.

As regards the cells (*c*), it is perhaps most probable that they represent new-formed elements belonging to the *cancer*, and in which also the development of the secondary forms had not been reached.

The peculiar *formation of cysts* in bones, a phenomenon, according to Rokitansky, of very rare occurrence, is, probably, intimately connected with new-formations of connective tissue. But we have had no opportunity of making observations on this subject.

An extensive tumour composed of connective tissue, situated in the continuity of the bone, was sent to us for precise determination. It was seated in the sacral region, covered by the moveable integument, and had been taken from a child three days old, which presented no other, visible, outward deformity. We found a subovoid vascular tumour, about three inches long in its greatest diameter. The borders were defined; and the surface, in consequence of several deep indentations, presented a coarsely lobate appearance. The growth protruded on the one hand towards the surface, affording in many places an indistinct fluctuation; and, on the other side, it encroached upon the pelvic cavity. The separate portions of the superficial lobules, exhibited, particularly under a lens, a well-developed vascular system, and, here and there, transparent cysts projected, the largest of which was 0·96″ in diameter. The examination of the surfaces of a perpendicular section showed the following particulars: 1. Cartilaginous portions of the *sacrum* and *coccyx* (fig. 113, *b b*). 2. Some larger (*a*) and smaller cysts were opened, affording a gelatinous, tenacious, or glutinous fluid containing *flocculi;* their walls, on the inside, were sometimes smooth, sometimes

furnished with ridges projecting into the cavity; and they communicated with each other in such a way, that a slender probe could be pushed from one of the larger cysts into the others. Some of the cysts were so small, as to be but just visible to the naked eye, like hemispherical and fissure-like depressions. 3. Groups of papillary growths, either sessile or pedunculated, were observed in the cysts, which appeared to be either wholly or partially filled by them. Similar growths were noticed, also, in great numbers, in simple shallow depressions (*c c*).

FIG. 113.

Under a powerful lens, the forms of the *papillæ* proved to be very various—hemispherical, conical, clavate, or resembling a cock's comb.

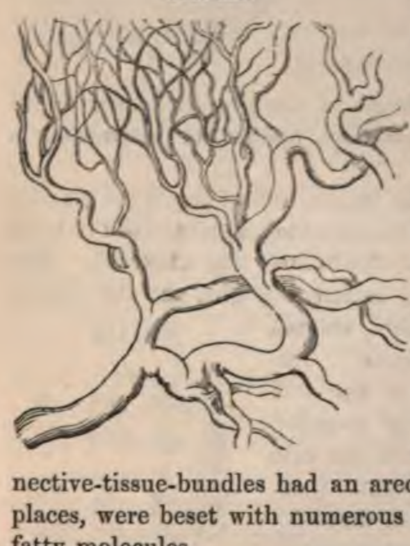
On the inner surface of the larger, and of the three smaller cysts which were opened, the remarkable occurrence of the most beautiful and perfect ciliated epithelium was observed. The ciliated cells (fig. 114, *a*) were usually straight, and the crowns of *cilia* everywhere very distinct, though of course their motion had ceased. The attached end of the body of the cell was sometimes attenuated or rounded off, or, in some instances, drawn out into two closely approximated points (probably ciliated cells in process of division). The forms, which were rounded below, were occasionally wider in proportion to their length, and consequently resembled the ciliated cells found, for instance, on the tongue and pharyngeal mucous membrane of the Frog. The oval *nucleus*, as usual, was situated in the lower part of the cell. Some parts of the inner sur-

FIG. 114.

face of the cysts were lined with the common, flattened, tesselated epithelial cells (fig. 114, *b*), the larger of which usually presented an angular outline, and one, or perhaps two *nuclei*, with a very prominent *nucleolus;* the smaller cells were more regularly polygonal. The elevated ridges on the wall of the cysts, were not invested with the simple layer of *epithelium*, exhibiting nothing but loosely connected, immature connective-tissue-elements, which, as well as the *epithelium*, had become partially detached, and were the cause of the flocculent turbidity in the fluid of the cyst above adverted to.

The vascular system was most developed in the posterior and upper part of the tumour. Large, much contorted vessels subdivided at once into slender capillaries, some of which were as fine as those of the brain (fig. 115). The delicate ramuscules were given off at an acute angle, and followed a straight course; arched loops were, here and there, apparent. The ramifications of the vessels formed groups as if belonging to lobules. The walls, even of the larger vessels, were very delicate and contained no annular fibrous coat. The parenchyma of the tumour was composed of minute connective-tissue-elements, groups of which appeared to be in a state of fatty degeneration. The connective-tissue-bundles had an areolar disposition, and, in many places, were beset with numerous granule-masses and brilliant fatty molecules.

Fig. 115.



This highly developed growth obviously belongs to the class of new-formations of connective tissue, and, as the formation of cysts had been reached in it, it will here be termed *cystosarcoma*. But besides this, as it had originated from bone, it might also be termed *osteo-cystosarcoma*. The development of the cysts in this case might be traced in an ascending series—commencing with dilated, intercommunicating *areolæ*.

§ 10. Parotid gland.

In order to understand, fully, the new-formations of connective tissue, which take place in the parenchyma of these acinose glands, we must first have a clear idea of the structure of organs of this kind; and, above all, is it requisite to have a distinct notion of the connective-tissue-framework. This consists of arborescent, fibrous bundles, which arch round and enclose the groups of terminal vesicles of the racemose gland, sending processes between the separate lobules. The connective-tissue-bundles are accompanied by vessels, which, like the former, split into branches and ultimately break up into a capillary plexus surrounding the terminal vesicles. The connective-tissue has a distinctly areolar disposition; the terminal vesicles lying in the *areolæ*, and the corresponding excretory ducts of the lobules, in the areolar passages.

With this brief preliminary sketch we shall proceed to the description of two tumours of connective tissue, which were situated beneath the *aponeurosis parotideo-masseterica*, and in all probability originated from the parenchyma of the parotid gland. Schuh has found that tumours of this kind are always *beneath* the aponeurosis in question, sometimes so loosely connected with the surrounding parts as almost to allow of their being detached with the fingers alone, but sometimes so closely united with the anterior and inferior part of the gland, that a portion of the latter must inevitably be removed with them.

A tumour removed by Professor Schuh from the region in question, was about the size of a pomegranate, and surrounded by a strong tunic of connective tissue, closely united to the superjacent fascia of the parotid gland. The surface presented several botryoidal projections, very tough and resistant to the feel; the surface of a section was pale, dry, partly pervaded by consistent, tendiniform, glistening streaks, running in various directions, partly of a more lax, granular texture in the light-yellow spots, which were enclosed, as it were, in capsules of the dense, streaked tissue, and appeared like masses of a softer substance nearly filling the *areolæ*, and which could be easily removed by means of the needle. Structures were also apparent, connected with the strong connective-tissue-

capsule either by one or by several pedicles, and which, sometimes to the naked eye alone, sometimes only under water with the aid of a lens, proved to be groups of *papillæ*; the groups, mostly wart-like, after their removal, left an opening, occasionally as large as a lentil. Fissure-like openings were here and there apparent. The elementary constituents were connective-tissue-cells of the smallest kind, such as are usually met with in the *corium* of the external integuments; the usual transitional forms of these cells were noticed. The *papillæ* had a superficial layer of small, polygonal cells, enclosing an oval *nucleus*, whilst their proper body consisted simply of immature connective tissue with a few fibres. The more consistent parts were composed of very large bundles of connective tissue, enclosing narrow *areolæ*; these bundles were also accompanied by numerous elastic filaments, and by a proportionately small number of blood-vessels. The patient had in the same region a long cicatrix, where, according to his account, a similar tumour had been removed some time before.

A sarcomatous tumour, about the size of a walnut, was removed, also, by Professor Schuh, from the inferior maxillary region. It was pale, dense, of granular texture, and pervaded only by few vessels. The section of the somewhat projecting, equal-sized granules was not smooth, and afforded but a small quantity of fluid on pressure. The uniform granulated texture gave the growth an appearance not unlike that of an acinose gland. Each lobe was subdivided into several lobules which were parted by a fibrous tissue. The apparent granules (*acini*) could be readily isolated by means of the needle, and consisted of bundles of connective tissue, giving off several delicate secondary branches; to each of the latter corresponded a rounded *papilla*, which was itself covered with an epithelium-like superficial layer composed of minute polygonal cells (fig. 116). These groups of *papillæ*, supported upon a com-

Fig. 116.

mon pedicle, were always enclosed in a capsule of connective tissue. The proper *parenchyma* of the papillary growths consisted partly of rounded cells (*a*), with an excentric *nucleus* occupying nearly the whole of their contents, partly of fusiform cells (*b*), in which also, the *nucleus* was of comparatively large size. These *papillæ*, therefore, in form analogous with the ultimate vesicles of an acinose gland, but with which they are by no means to be identified, are new-formations of connective tissue. They were constructed in the same way in all parts of the tumour.

The main question with respect to the development of the tumour lies in the determination of the mode in which the uniform, granulated structure is brought about. In our opinion, two cases only are possible; the new-formation had originated either in the superficial investing coat of connective tissue of the parotid, or in the interstitial connective tissue of the gland. But when the uniformity of the granulated structure, but more especially the, occasionally, very manifest, intimate connexion of the growth with the glandular *parenchyma*, are considered, the latter of these two possibilities seems by far the more probable. The processes of connective tissue noticed above, between the separate lobules, and the connective-tissue-capsules of the groups of terminal vesicles, would, consequently, have to be regarded as the proper *nidus* of the papillary new-formation, in consequence of which the true glandular parenchyma was destroyed. We have already found that a precisely analogous process takes place in subcutaneous condylomata, in which the new-formation also originates in the connective-tissue-capsule of a sebaceous gland. If we suppose a similar process to occur in the *acini* of an entire lobule of the parotid gland, a tumour will be produced whose fundamental framework is an areolar tissue, and whose papillary new-formations are lodged in the *areolæ*; and if the latter, with their parenchymatous contents are pretty nearly of uniform size, a uniformly granulated structure will thus be produced.

It is also clear, that when serous exudations come to be poured out into several *areolæ*, the tumour might be designated *cysto-sarcoma*; and it is also evident, that, as in the preceding instance, the papillary new-formation is occasionally developed only in many situations, whilst in others, being replaced by

the formation of strong connective-tissue-bundles, it either does not exist at all, or only in an abortive condition.

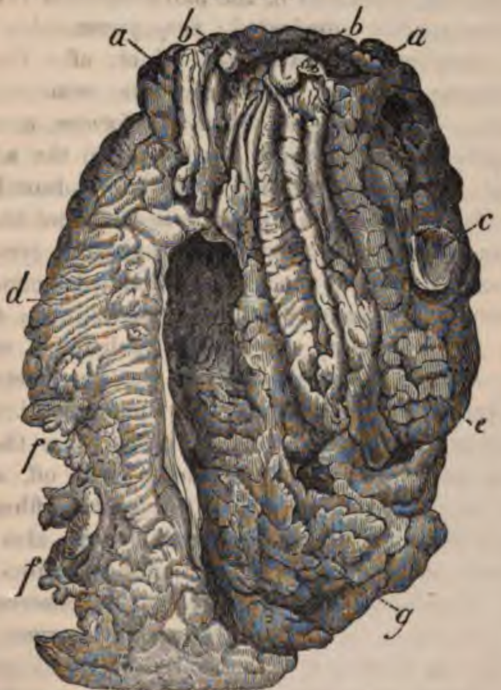
§ 11. Mammary gland.

It is well known, that the tumours which most frequently occur in these glands are of the kind termed *cysto-sarcoma*. J. Müller has given them different names, according to their form, distinguishing: 1. *Cystosarcoma simplex*, when the cysts lodged in the parenchyma of the *sarcoma* have smooth walls, or only a few nodular excrescences. 2. *C. proliferum*, when, on the walls of the cysts, smaller cysts, or multifid growths, sometimes pedunculated, sometimes sessile, are seated. 3. *C. phyllodes*, when the vegetations, more closely crowded, and foliaceous, or like cocks' combs, &c., are in mutual apposition. It must not be supposed that these different kinds are absolutely distinct, for two, or even all the three forms, may be found coexisting in the same tumour; the former, therefore, can only be regarded as developmental forms.

A very large *cystosarcoma* of the breast, which had perforated the integuments to a considerable extent, consisted of several lobes separated by rather deep fissures; one of which only could be subjected to closer examination. On the cutaneous aspect, it was redder than elsewhere, and the surface was rendered nodular by bifurcating depressions (fig. 117, *a a*). The coarser anatomical structure, as displayed by the unfolding of the separate parts without rupture of their natural connexions, was at once seen to be chiefly lamellated. The *lamellæ* proceeded from centres placed at various distances apart, and presented various dispositions and forms; from three to six of them would run contiguously for a length of about 0·78—1·95″, occasionally seeming to coalesce at the other end of their course; they were sometimes thin and flattened (0·44‴, or less, in thickness), sometimes nodular and contorted. One of their edges was attached, the other free, the latter being marked with shallower or deeper indentations; both sides of each lamella appeared smooth, or furnished with slight elevations and depressions; in many places, however, the lateral surfaces presented globular or clavate excrescences, which floated out in the water. In portions displaying a

wider surface, though marked with parallel grooves (as at *d*), no separation into distinct lamellæ capable of being reflected could be perceived. In other situations (as at *e*), the surface

Fig. 117.



exhibited a structure composed of lobes separated by fissures. The *lamellæ*, superimposed one upon another like the sheets in a book, occasionally presented some resemblance to the leaves of a plant (as at *g*). Lastly, there were very numerous, polypoid excrescences in the form of pointed, blunt, broad, globular, clavate, large or small, solitary or grouped *papillæ* (*f f*). All these productions were enclosed in a dense sheath of connective tissue, which sent down processes between the larger groups of the lamellated and papillary growths, whence were produced narrow *areolæ*, into which the excrescences and other growths above described, projected, free, and washed by a glutinous, clear fluid.

Near the points whence the *lamellæ* radiated, or occasionally,

also, in other indefinite spots, there might be observed nodules, of the size of a lentil or bean, which, by reflected light, presented an opalescent brilliancy, and were sometimes rounded, sometimes subdivided into several lobes by a few grooves (*b b*). These nodules lay quite free in the parenchyma of the tumour, and could be readily enucleated; they presented a tolerably consistent, peripheral substance (*c*), which, after the removal of the pultaceous, whitish, friable contents, retained the form of a *sacculus*. The latter, as well as the former, proved to be layers of epidermis-cells, which swelled up on the addition of carbonate of soda, together with much free, minutely divided *olein* in the form of globules; *cholesterin* could not be detected.

The more *intimate structure of the papillary growths* may be thus described. They had a well-defined boundary, the border presenting deeper or shallower indentations; the superficial layer was composed of minute, polygonal cells, with rounded *nuclei*, and the *parenchyma* of small connective-tissue-cells, with very prominent *nuclei*; the fundamental framework was constituted of fibrous bands radiating from the base of the *papillæ*, and which were sometimes given off, at a right angle, like lateral branches, from the central fibrous stem. The younger buds, seated on the parent *papilla*, also exhibited a well-defined outline, and contained simply a fine-molecular substance. Papillary excrescences were also observed, which, particularly towards their rounded extremity, were rendered opaque by fat in a state of minute division, and pigmentary matter, and which were, consequently, in an atrophied condition. This was especially evident in many situations, as, for instance, towards the superficial part of the tumour.

The *lamellæ* had essentially the same structure, the fibrous bands following the longitudinal axis. The *vessels* in the papillary excrescences accompanying the fibrous tissue, were wavy, and usually in small number. Bloody points and spots were visible at the *apices* of many of the *papillæ*; and the greater vascularity in those spots was discernible towards the cutaneous surface. The structure of the vessels themselves, proved, on the application of acetic acid, to resemble that of the capillaries; the smaller class of vessels occasionally presented lateral protrusions, and rapidly diminished in size; blood, moreover, appeared to be contained in *areolæ*, without any

independent walls. The vessels were also seen to give off, very much elongated, attenuated processes, filled with blood (incipient connecting branches). Upon the addition of acetic acid, a tissue, consisting of elongated meshes, came more distinctly into view in the denser portions. Convoluted, elastic filaments were, comparatively speaking, present only in small number.

A large cystosarcoma of the breast, removed by Professor Schuh, presented, in many parts, a remarkably uniform, lobulated aspect. Each lobule was surrounded, and united to the contiguous lobules, by a tunic of connective tissue, and consisted of numerous larger and smaller nodular protuberances (fig. 118), which nearly filled the investing capsule. The superficial coating was composed of very delicate, pale cells with fine-molecular contents, but which only occasionally presented a distinct, oval *nucleus*. The proper parenchyma consisted of extremely minute connective-tissue-cells, which, from their large, closely crowded *nuclei*, might, without care, have been mistaken for pus-corpuscles. The *stroma* was constituted, as in the former case, of delicate bundles of connective tissue.

Fig. 118.

In a *cystosarcoma* of the breast, about the size of a pomegranate, extirpated by Professor Chiari, the apparently acinose structure was very distinctly displayed in the cut surface and in thin sections. When the latter were treated with carbonate of potass, the areolar structure of the investing connective tissue surrounding the lobules was evident; the latter, however, were contained in the *areolæ*; it was clear, at the same time, that these *areolæ*, when distended beyond a certain size,

were filled with a serous fluid, and that only a few excrescences composed of connective tissue projected into them, whilst the investing tunic itself presented the aspect of a smooth membrane. The *areolæ* (cysts), which represented, as it were, only the segment of a sphere, were occupied by a light-yellow, rather turbid fluid, presenting, besides numerous, isolated fat-globules, of all sizes, aggregations of such globules, either spherical, or bulging on one side. Several of these granule-masses were of considerable size, and presented a general resemblance to the *colostrum-corpuscles*. The turbidity of the fluid was also increased by the presence of spherical cells with a transparent, round *nucleus*, and whose contents were in a state of incipient fatty degeneration. It is, perhaps, very probable, that these cells stood in a genetic connexion with the granule-masses, which, however, without doubt, were increased by the agglutination of fat-globules, since the largest granule-masses exceeded in size the largest of the cells by at least four times their diameter. From the nipple, which was removed at the same time, a yellowish fluid could be expressed, and the communication between the lacteal ducts and the cysts was demonstrated by the introduction of bristles.

The lobulated new-formations of connective tissue (apparent *acini*), which could be easily removed from their capsules by means of a needle, consisted of mostly fusiform, short cells, with a pale, oval *nucleus* and distinct *nucleolus*. In many parts of the tumour, moreover, immature forms of connective tissue were seen, imbedded in a gelatinous, structureless *stroma*. Acetic acid produced a decided opacity both in the latter and in the delicate papillary new-formations.

From these instances, it appears: 1. That *cystosarcoma* of the breast is a new-formation originating in the interstitial connective tissue. We do not, therefore, coincide in Reinhardt's view, that the *cystosarcoma mammæ proliferum* arises in a hypertrophic development of the normal glandular elements.

2. That the new-formation usually assumes a papillo-dendritic form, and grows into the partly closed *areolæ* of the *acini*.

3. The proper glandular substance is sometimes suppressed by this growth, sometimes dissolved by the formation of a serous fluid.

4. In consequence of the latter process, an apparently acinose structure is produced; but the proper *acinus* of the gland is removed and replaced by a papillary new-formation. Meckel states that these *papillæ* are certainly solid, and arise from the glandular follicles by inversion.

5. A cyst is produced from the coalescence of several *areolæ* of a destroyed *acinus*.

6. The fusion appears to involve the excretory ducts also, which are surrounded with a sheath of connective tissue; and by the dilatation of these tubular pouches, cavities are produced, containing a serous fluid, which (as in the last case) occasionally communicate with the lacteal ducts, as was first noticed by H. Meckel. The fluid discharged from the nipple, under these circumstances, is not a glandular secretion, but must be regarded as a effusion deposited in the hypertrophied cystoid *areolæ*.

7. The new-growths of connective tissue take place, in groups, in the lobules of the gland; owing to which, the lobules composed of the new-formation acquire a connective-tissue-capsule, strictly defining them from the sound parenchyma.

The *growth* of the cystosarcoma, according to our observations, may, in general terms, be described as observing the following course: A plasma is secreted into the nutrient vessels forming the capillary plexus around each *acinus*, and from which the materials for its proper secretion are also afforded. This plasma, owing, probably, to its being poured out in too great a quantity at once, gives rise to a new-formation. The superfluous material no longer applicable to the nutrition of the organ, remains infiltrated in the connective-tissue-capsule of the *acinus*, where it induces a more vigorous production of cells. On the one hand, a hypertrophy of the capsule is produced; and, on the other, a papillary new-formation of connective tissue, on its inner surface; the *papillæ* continue to grow by a sort of gemmation, and at length fill the cavity, previously formed at the expense of the glandular substance. By reiterated transudations, which appear gradually to assume a hypertrophic character, the *areolæ* become more and more distended, whilst the papillary connective tissue and the fibrous *stratum*, constituting the wall of the cyst, continue to

advance from the periphery. The inner surface of the cysts, and the outer surface of the *papillæ*, acquire an epithelial covering. The pathological new-formation is characterised, as everywhere else, by its unsymmetrical organization—that is to say, by an organization much advanced in many parts whilst stunted in others, in which, portions of tissue, in a state of involution, may be observed.

Rokitansky regards the verrucose, foliated, clavate growths, as originally hollow, and thinks that connective tissue is developed in their interior. According to him, they grow by a kind of protrusion of the originally hollow process. But this can only so far be regarded as hollow, that it contains a fluid, organizable blastema. In the General Part, we have already expressed our views with respect to the ideal mode in which the development of a papillary new-formation takes place; and will, here, merely add, that the *protrusion* theory, which also plays a part in the history of the development of these growths, does not properly deserve that name, inasmuch as the protrusion (Ausstülpung) of any membrane without a pressure from the sides is unintelligible; but since, in that case, the bulk would remain the same, whilst, in the organic growth, a manifest augmentation of volume takes place, the notion of a *protrusion* is manifestly insufficient to account for the phenomenon.

§ 12. Ovary.

The new-formations of connective tissue in the ovary are usually, and, as is well known, very extensively associated with that of cysts, so much so, in fact, that the entire organ appears, as it were, filled with the latter. These cysts, unless, as is sometimes the case, they occur isolated in the parenchyma of the ovary, project, in very various degrees, above the surface, and contain sometimes a thin, watery, yellowish, yellowish-green, or blackish-brown fluid, or a more tenacious, gelatinous, melicerous, yellowish-brown, or reddish-brown substance. In structure, they differ in no respect from other cysts, have sometimes a stronger, sometimes a more delicate connective-tissue-tunic, in which the blood-vessels constitute very elegant plexuses, at the same time rapidly diminishing in size. These vessels, as

usual in those of new-formation, are characterised by their simple structure, a circumstance which may afford a reason, in the diminished resistance of the walls of the vessels, for the readiness with which hemorrhages take place into these cysts. It is obvious, that the simple layers of flattened epithelial cells, often in a state of fatty degeneration, lining the inner surface of the cyst-wall, cannot afford any effective resistance to the flow of blood, which, thus enclosed in the cavity of the cyst, dies, and passes through the well-known various metamorphoses already described (*vid.* "Atrophy of the Blood," p. 129).

To the cyst-walls are occasionally attached papillary new-formations, enclosing a transparent cavity and branched in a dendritic form; and which, superimposed one upon another, constitute groups entirely filling the cyst, excepting a narrow space; or, on the not quite smooth parts of the inner wall of the cyst, are found trabecular networks of connective tissue, which also project, more or less, into the cavity, and are constituted of fusiform cells in close apposition, imbedded in a fibrous framework. The secondary cysts, seated on the inner wall of the so-termed parent-cyst, supported on a wider or narrower base, are of interest. They often occupy nearly the entire *lumen* of the parent-cyst, and include a tertiary formation of cysts. These pill-box cysts, also, present the structure proper to such growths.

The entire mass of cysts is held together by an areolar tissue, in which more or less distended *areolæ,* about to be transformed into cysts, may be observed. The finely curled or wavy connective-tissue-bundles are usually imbedded in a molecular substance having *nuclei* disseminated throughout it. The very fine, straight, reticulated fibrous elements, unaffected by acetic acid, which occur both between the cysts and in their contents, correspond in character with mucin-filaments, and constitute, in this situation, without doubt, the "mucous tissue" of Virchow.

The portions of tissue in *a state of involution,* which are found, in considerable abundance, in what are termed *compound cystoid growths,* are manifested partly by the whitish-yellow contents enclosing a large quantity of fat, or by their contents being of a dark colour and containing pigment; the papillary new-formations lose their transparency, and occasionally present, at their rounded extremity, a granular substance soluble in

acetic acid, sometimes with the evolution of air-bubbles, but which in other situations appears to be unaffected by that acid. The matter taken from the *papillæ* affords no further morphological characters, and, probably, in the latter case, represents a colloid substance. The involution of the interstitial tissue of the cysts takes place in an analogous mode.

It was, formerly, very generally supposed, that the cysts in the *parenchyma* of the ovary originated in the Graafian follicles, but no direct proof of this was ever given. Even Rokitansky, who regards it as probable that the simple cysts are, in many cases, developed from the follicles, doubts that such is their origin, in those instances in which their number far exceeds the usual number of Graafian vesicles, holding them to be new-formations. In his late work upon 'Cysts,' he has assumed an endogenous formation in those of the pill-box kind; a view which is based upon his theory already adverted to in the General Part (p. 88). With reference to what we have already stated on this matter, we would, in addition, remark, that these pill-box cysts are always attached by means of a common basis upon the inner wall of the parent-cyst, and, in such cases, we conceive that the supposition is more probable that they arise in new-formations of connective tissue in a state of serous degeneration, and growing one within the other. For, even according to Rokitansky, villosities may be observed sprouting from the inner surface of the cysts and supporting a transparent vesicle, and whose contents are manifestly in a state of incipient serous degeneration. These villosities, therefore, should be regarded as pedunculated cysts (*vid.* those on serous membranes, p. 362).

The monstrous development of many ovarian cysts may be referred, either to a coalescence of several into one, or to the increase of one at the expense of the others; in any case, a new-formation of connective tissue, and of vessels, limited to particular portions, always exists in the cyst-walls.

Those ovarian cysts from whose wall, hairs, as well as sebaceous and sudoriparous glands, teeth, and bones grow, are of high interest. Although the description of these growths does not properly belong to this place, still we shall consider them here, since they are in intimate relation with the new-formation of connective tissue. We have only once had an

opportunity of examining *hairs* from such a situation; their bulbs were scarcely enlarged, and in structure closely resembled those of the human, lanuginous hairs, that is to say, they were not rounded off at the extremity, but penicillar, although the hairs were several inches long, and in thickness not far behind the finer hairs of the head. They were twisted and matted together into a coil, of very various colour—brown, black, or light blonde,—and they occasionally contained a medullary substance; they were glued together by a fatty, dirty yellowish-brown, lumpy, interstitial substance, in which were noticed isolated, epidermoidal deposits, composed of very flat, large cells, furnished with a comparatively small *nucleus*, and which swelled up on the addition of carbonate of potass. The cholesterin-crystals (of which none were observed) had probably been destroyed by the process of decomposition.

Sebaceous and sudoriparous glands have been found by Kohlrausch and Heschl in cysts of this kind, and disposed in the same way as in the skin. The latter of these authors noticed, in the same cyst, together with the accessory cutaneous organs, a horseshoe-shaped *bone*, an inch in length, and three lines thick, which occupied the wall beneath the spot covered with hair, and attached to it by a perfectly normal periosteum, and a layer of very lax connective tissue; it had several jagged processes, upon which conical cartilages were distinctly articulated, as large as a hempseed, and furnished loose articular capsules.

R. Owen has shown that the structure of an incomplete *molar tooth* from an ovarian cyst was precisely analogous with that of a normal tooth.

It has also been assumed that cysts of this kind, enclosing organized parts, originated from the Graafian follicles; but the circumstance, that cysts containing hairs (Rokitansky), and even furnished with sebaceous and sudoriparous glands (Kölliker), have been found, the former in the breast, and the latter in the lungs, renders this supposition extremely doubtful.

Formations, composed of fibrous connective tissue, in the form of firm nodules projecting above the surface, or of cicatriform callosities, are, in this situation, connected with a previous destruction of the follicles, whose contents, as in *oophoritis*, are metamorphosed into a substance resembling

coagulated albumen. The nodules, sometimes sessile, sometimes pedunculated, which are seated on the surface, arise, without doubt, from a papillary new-formation of connective tissue; and the callous thickenings are referable to a hypertrophy of the interstitial connective tissue.

§ 13. Testis and Prostate.

New-formations of connective tissue rarely occur in the substance of the *testis*, whilst they may often be noticed on the outer surface of the *tunica albuginea*, in the form of sessile or pedunculated nodosities. A soft, yellowish-red growth, about the size of a pea, in that situation, presented a smooth surface both on the outside and in a section, and only a small quantity of a scarcely turbid fluid could be expressed. Superficially, the growth was constituted of layers of flattened, polygonal, epithelial cells, beneath which were the immature connective-tissue-formations, in the shape of fusiform cells, with a comparatively large *nucleus*, containing 1—2—3 *nucleoli*. These elementary parts were arranged in a lobate manner, whence the texture of the growth presented a granular aspect. Bloody points, also, were visible in these lobules—masses of newly formed blood-corpuscles, appearing, as yet, to be unconfined by any independent walls.

We have also noticed these new-formations of very firm consistence, and pale colour, or in the form of cysts, containing a clear, yellowish fluid. In one case, Schuh observed, in the cavity of the *tunica vaginalis*, a cyst, about the size of a lentil, of a brown colour, and floating free in the fluid; it was firm to the feel, and contained a dark-coloured, pultaceous matter. Besides this cyst, which had lost all organic connexions, he also discovered a thin, membranous, pedunculated cyst, as big as a pea, on the anterior surface of the *testis*. He has sometimes, also, observed an excessive growth of cysts; and has seen tumours arise in the *scrotum* in the course of a year, in the situation of the *testis*, larger than the fist, of a pyriform shape, slightly nodulated, tense, and of variable firmness in different parts.

New-formations of connective tissue occur in every *hydrocele*, constituting the ridge-like *trabeculæ* on the inner surface

of the sac, and which may be recognized as particles of connective tissue in the *flocculi* seen in the fluid when drawn off. In the latter, granule-masses and spermatic filaments are generally met with, which find their way into the sac through rupture of the spermatic cord, which is usually enlarged and thickened, or of some part of the *epididymis*. According to Rokitansky, new-formations, advancing inwards from the *tunica albuginea*, and inducing a secondary atrophy of the proper parenchyma of the *testis*,—the *tubuli seminiferi*,—are of rare occurrence.[1]

[1] [In Virchow's 'Archiv f. Path. Anat. u. Physiol.,' vol. vi, p. 310, 1854, is a paper on the "Appendicular Structures" of the Testis, by Professor H. Luschka, containing interesting observations on the subject, more especially of the cystoid growths so often observed connected with *testis*, and clearing up any remaining obscurity with respect to hydroceles containing spermatozoa. I have therefore thought it advisable here to introduce a brief abstract of the paper, so far at least as it relates to cystic growths on the testis.

Professor Luschka observes, "that two kinds of these so-termed hydatids of Morgagni may be distinguished, viz., the *sessile* and the *pedunculate*.

"The former are so common that their absence must be regarded as the exception. They are found, almost uniformly, beneath the head of the epididymis, at a point corresponding to the anterior extremity of its lower border. In the majority of cases the cyst is solitary; and when two exist, one is considerably smaller than the other. These appendages are usually of a rounded, or well-marked foliate shape, and as big as a pea or lentil, or even of a small hazel-nut. They have nothing like a peduncle, and are inserted beneath the *epididymis* in such a manner as to convey the impression of their being intimately connected with the substance of the *testis*.

"The sessile hydatid, almost always encloses a cavity, which, in many cases, communicates so openly with the seminiferous canal, that the hydatid may be taken to represent a vesicular dilatation of the extremity of the latter, projecting beneath the *epididymis*. Their contents always correspond with those of the spermatic canal, and accordingly, spermatozoa, in large quantity are frequently found in them; but occasionally only simple *nuclei* and cellæform corpuscles. The communication with the seminal tube, when narrower, can, however, always be demonstrated by the introduction of a bristle, or by mercurial injection. But not unfrequently, no communication of the kind can be discerned, and in these cases the cysts contain no seminal elements, their contents corresponding with those of the vesicles next to be considered, and which occur very frequently in the subserous connective-tissue of the *epididymis*, and less often in that of the body of the *testis*.

"These vesicles are mostly very small, of the size of a millet-seed, or of a pea, and of a rounded form. They usually project but little above the surface, presenting the aspect of pellucid spots on the epididymis. They are lodged in the subserous connective-tissue, and may be enucleated thereform. They afford no indication of any connexion with the seminal canal; nor can any trace of an obliterated

In the *prostate*, these new-formations are usually limited to particular portions, causing nodular enlargements. They are also accompanied with a new-formation of gland-substance,

tubulus to be discerned. They are, in fact, simply, serous cysts, which have no developmental relations with the constituent parts of the testis or epididymis, whose wall consists of dense connective tissue, with fine elastic fibres, and containing a clear fluid, of variable consistence, with numerous corpuscular elements. Very many of these are rounded corpuscles 0·0132''' in diameter, containing numerous fat-granules. But the greater part of the morphological constituents are smaller corpuscles, 0·0017—0·0026''' in size—*nuclei*,—together with a very delicate molecular matter, consisting of protein-substances mixed with fat-drops. Cysts of this kind, frequently present, besides the above elements, well-developed connective-tissue-corpuscles, exhibiting every phase from the elliptical shape through the fusiform corpuscle up to almost perfect connective-tissue-fibrils. These cysts have been examined, particularly by Gosselin ('Archiv. Gén. de Méd.,' 1848), who never found a trace of spermatic elements in them.

They sometimes enlarge into great cysts, which cannot possibly be distinguished, except upon dissection, from a common hydrocele [the small amount of albumen in the fluid, will always, perhaps, afford a sufficient diagnostic character from common hydrocele].

The *pedunculated* Morgagnian hydatids have no connexion whatever with the spermatic canal; they are less frequent than the sessile, and always solitary. The cyst is supported on a solid, slender peduncle, composed of connective tissue, and about 2–4''' long, arising from the rounded extremity of the head of the epididymis. By careful dissection, the stem may be traced downwards in the fissure between the epididymis and body of the testicle, running on the posterior aspect of the *vas deferens*, where it is gradually lost in the spermatic cord. The vesicular head contains cells, cell-nuclei, and a molecular substance with fat-drops in small quantity. But it is sometimes quite solid, and constituted throughout of connective-tissue-fibrils. It never communicates with the seminal canal.

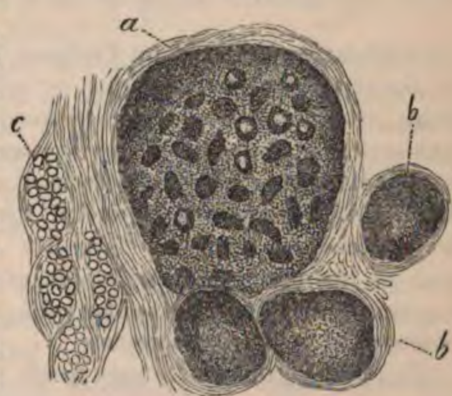
With respect to the genesis of the Morgagnian hydatids, satisfactory information is afforded in Kobelt's work, on the Parovarium in the female ('Der Nebeneierstock des Weibes, &c.' Heidl., 1847). The Wolffian body in the fœtus is furnished with a common excretory duct, which commences with a clavate dilatation. Numerous clavate tubules—the so termed cæcal *diverticula*—open into this duct on its inner aspect. The diverticula belonging to the middle portion of the duct are longer, and more closely placed than those situated nearer the upper and lower ends of it. These middle *diverticula* are transformed into the seminal vessels of the *coni vasculosi*; the upper ones, disappear in part without leaving any trace, and are, in part, metamorphosed into the sessile Morgagnian hydatids, which sometimes retain a communication with the seminal canal of the *epididymis*, and sometimes present the aspect of solid, or of hollow appendages, not containing any spermatic elements.

The cæcal diverticula of the lower part of the Wolffian body become the *vasa aberrantia Halleri* (superfluous vessels of Cooper, which may, also, sometimes dilate into seminiferous cysts.

The filament of Müller running upon the anterior surface of the Wolffian body, from the moment when the male sex of the embryo is determined,

and, in that respect, deserve the name of a hypertrophy. A middle lobe of the prostate, projecting into the bladder, of an oblong shape, and about an inch in its longest diameter, was somewhat flattened on both sides, and rounded above, and, on section, displayed a consistent, lobulated structure. It had a capsular tunic of connective tissue, and was attached by a broad surface. Its main constituent was very dense connective tissue, consisting of elements of small size. The capsule also contained elastic filaments and groups of epithelial-like cells, which could not be referred to the mucous membrane, as that was removed. The lobe which, for the purpose of making thin sections, had been boiled in acetic acid, dried, and afterwards treated with a solution of carbonate of soda, exhibited only in comparatively few places any appearance of glandular substance, which was imbedded in the growth, appearing as sharply defined opaque masses, surrounded by fibrous bands. In many of these spots, the molecular *stroma* presented more or fewer polygonal elements, filled with dark granules (fig. 119, *a*), and occasionally showing a clear *nucleus*.

Fig. 119.



loses all future significance, and is consequently atrophied. But it seldom disappears altogether, showing itself, at a subsequent period, on the head of the *epididymis* as a pedunculate Morgagnian hydatid, whose peduncle, as has been stated above, runs beneath the serous tunic, between the testis and epididymis, and is gradually lost, having no relation whatever to the seminal ducts.

In the female embryo, the Müllerian filament becomes the oviduct; and the hydatid vesicle, so often met with at the extremity of the broad ligament, corresponds genetically to the cæcal termination of the excretory duct of the Wolffian body.

The above exposition, sufficiently shows that hydroceles, in the fluid of which spermatozoa exist, have no necessary connexion whatever with the *tunica vaginalis*, as (notwithstanding the observation in the text), is known to be the case from daily experience.—Ed.]

The glandular ducts (*b b*), divided more transversely, contained merely a dark-grey molecular substance. The fibrous bands crossed each other in all directions, and, lodged in the *areolæ*, groups of *nuclei* (*c*) were visible, belonging, for the most part, to the fusiform cells which lay in a transverse direction.

The excretory ducts of the other two, considerably enlarged lobes of the prostate, were dilated, and furnished with sinuous protrusions; on pressure, some afforded a clear, and others a milky, turbid fluid. The glandular lobules, sometimes before, sometimes after treatment with carbonate of soda, were seen, in sections, to be far more numerous than in the accessory middle lobe.

§ 14. Eye.

A *chalazion*, removed by Professor Seidl, proved to consist of connective tissue remaining in various stages of development, and interrupted by interposed groups of aggregated, fine-molecular, brownish-yellow masses.

On examining the newly formed connective tissue at the borders of a punctured wound of the *cornea* in the Rabbit, we noticed, so early as forty-five hours after the infliction of the injury, a considerable quantity of fusiform cells, together with minute, granular cells, which might readily be confounded with pus-corpuscles.

In *synechia*, delicate fibrous bands are seen stretching from the *iris* to the *cornea*, or to the capsule of the *lens*; whether these bands are always referrible to connective tissue of new-formation, that is, whether they are always produced from fibre-cells, must, we think, at present, be regarded as very doubtful. We attempted to produce a *prolapsus iridis* at the edge of the *cornea* in a Rabbit, but the animal died on the second night, and we found in the wound merely a large quantity of grouped pus-corpuscles. In the anterior chamber of the eye not operated upon, there was a membraniform coagulum, which obeyed the movements of the aqueous humour; and when the *cornea*, which was in a perfectly normal condition, was opened, it could be readily removed by the forceps. It constituted a greyish-yellow pellicle, exhibiting, in thin portions, elongated, straight, fibrillar streaks, crossing each other in various direc-

tions, and without a trace of connective-tissue-cells. These streaks bore the closest resemblance to mucin-filaments, and were manifestly referrible to a coagulation of the fluid exudation.

§ 15. Brain.

Wavy fibrous bands, even of considerable size, are found, as is well known, in what are termed apoplectic cysts, though this name is inappropriate, since they merely constitute an irregular, ill-defined capsule of connective tissue around apoplectic effusions in a state of incipient involution. They are covered with a fatty, molecular, and orange-coloured substance, and should not be confounded with the delicate, reticulated filaments observed in old apoplectic effusions, and which are, in fact, coagulated *fibrin*.

Very considerable layers of connective tissue, of precisely the same kind, are apparent in the cicatriform contractions succeeding the absorption of exudations, in the wall of abscesses, and in the investing tissue of tubercle, and of cancer, in the brain. We have also noticed groups of formations of embryonic connective tissue on the cortical substance of the cerebral hemispheres in idiots.

New-formations are, perhaps, far from rare in the very delicate, interstitial connective tissue of the brain; but, at present, we are unacquainted with any suitable method of conducting the examination of sections of that organ. Professor Czermàk informs us that Purkinje has obtained very instructive sections from portions of the brain which had been hardened in dilute chromic acid, and subsequently dried and treated with oil of turpentine.

It has been already remarked that the interstitial connective tissue of the nerves may become hypertrophied, and induce a secondary atrophy of the nervous substance (*vid.* p. 181).

§ 16. Blood.

Virchow has found in the blood, after intermittent fever, cells, sometimes colourless, sometimes containing black pigment-granules, and of a round, conical, or fusiform shape. From the figures given of them we must conclude that they are con-

nective-tissue-cells, and would at the same time refer to the precisely analogous cells, long well known, which have occasionally been noticed in the venous blood in cases of cancer of the liver.

Dr. Planer showed us newly formed cells from fibrinous clots in the heart, which also escaped in great abundance from the coagulated fibrin, in the form of elliptical, oval, granular, much-indented elements, often united in pairs, or even forming entire chains. We rank these bodies, also, with connective-tissue-cells, and would, here, merely remark that they very closely resemble the elliptical cells occurring in gelatiniform *cancer*. In a venous coagulum, we have also noticed various kinds of connective-tissue-cells. That these are not formed, until a blood-stasis has been established, is self-evident.

§ 17. Structures of an uncertain nature occurring in the subcutaneous adipose tissue.

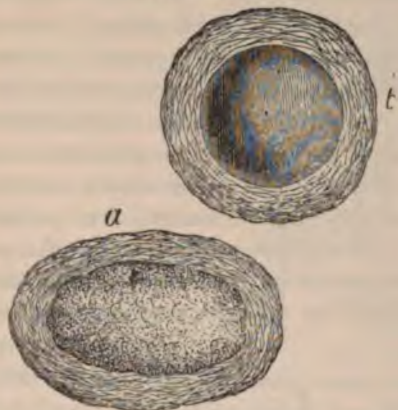
In placing these, as yet undescribed, bodies at the end of the category of new-formations of connective tissue, we do not mean, by so doing, to imply that they belong to it. We have sometimes found in the sub-cutaneous adipose tissue of the scalp, and on one occasion in that of the fore-arm, and volar surface of the hand, oval or round, greyish-yellow, or brownish-yellow, sharply defined bodies, about 0·088‴ in size. They consisted of a thick capsule, composed of circular fibrils and enclosed a corresponding cavity filled with granular corpuscles (fig. 120, *a*). In other cases the latter were less distinct, being replaced by homogeneous brownish-yellow substance (*b*). These capsular structures were placed at definite distances apart, in many situations, whilst in others they were wholly wanting.

Time would not allow of more extended observations with respect to these bodies, which, as we learn from Professor C. Langer, are frequently to be seen in the scalp.

In some researches on the structure of the skin in young specimens of *Hyla viridis* and *Rana esculenta*, we remember to have noticed, in the integument on the inner side of the thigh (more particularly in *Hyla viridis*) closed capsular organs, filled with a grey, nucleated substance (the *nuclei* being not un-

like those in the lymphatic glands), in considerable number, and either isolated or placed in groups of ten or more together.

Fig. 120.



Without entering into any particular details, we would here remark that these grey, encysted nuclear masses, which are rendered more distinct by acetic acid, and ultimately disappear in the alkaline carbonates are, probably, lymphatic glands.

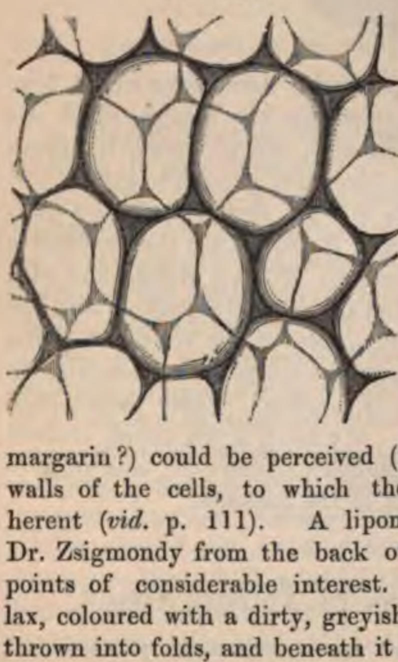
The above-described organs in Man should also, most probably, be regarded as lymphatic glands, since they enclose a substance precisely like the contents of those glands, and with respect to their structure exhibit considerable analogy with the capsules of the Peyerian glands, and of the solitary follicles of the intestine; the one marked *b* would, consequently, represent a follicle in a state of involution. Their pathological import is at present obscure. We have, a few times, noticed them in a perfectly normal condition of the skin, and once in *pemphigus*, on the inner aspect of the fore-arm.

VI.—NEW-FORMATIONS OF ADIPOSE TISSUE.

The fat-cell is characterised by its enormous productivity, which may involve the whole of the sub-cutaneous adipose tissue, and especially that of the abdominal integuments, or be circumscribed within narrower limits, when the tumours, known under the name of *lipoma*, are produced.

A tumour of this kind, which was removed by Professor Chiari from beneath the integuments between the *scapulæ*, was about as large as a middle-sized fist, had a very vascular envelope of connective tissue (nutritive capsule), which was tensely spread over the lobular elevations, and sent down, broad, vaginal processes between the separate lobules. The parenchyma was of a sulphur-yellow colour, divided by the processes of connective tissue into several compartments, of a soft, elastic consistence, and afforded on pressure a large quantity of brilliant fat-globules. The blood-vessels in the capsule of the tumour, and in the light-coloured, firm processes, were serpentine, and, in many places, by means of a powerful *lens*, a close, polygonal meshwork, formed by them, could be, here and there, perceived. The fat-cells were characterized, in general, by their enormous size and unequal dimensions (fig. 121); for whilst the smaller were not bigger than the normal fat-cells, the larger had a diameter of 0·088‴, or even more. In their contents, they presented no remarkable differences, being everywhere filled with a thin, fluid fat. In thin sections, taken from a dried portion of the tumour, the well-known, radiating, crystalline bundles of margaric acid (or margarin?) could be perceived (fig. 122) within the collapsed walls of the cells, to which the mass of crystals was adherent (*vid.* p. 111). A lipomatous tumour, removed by Dr. Zsigmondy from the back of the thigh, presented several points of considerable interest. The skin covering it was lax, coloured with a dirty, greyish-brown pigment, and readily thrown into folds, and beneath it could be felt hardish nodules, some of bony consistence. A section across the tumour at once showed that the groups of fat-lobules had entered into a state of retrograde metamorphosis. These parts had assumed a dark-yellow or brownish-red colour; their consistence was

FIG. 121.



increased, and elasticity diminished, whilst calcareous plates could be perceived here and there; and some lobules, of the size of a bean, were incrusted with earthy matter. The dense, light-yellow portions, contained collapsed fat-cells, in such close apposition that the folded cell-membranes constituted concentric layers; fascicular masses of crystals were not observed in this situation. In the darker-coloured parts, in which, occasionally, a few, scattered, calcareous particles were imbedded, usually either no fat-cells at all, or only imperfect ones, were any longer discernible, an amorphous, dark, brownish-yellow mass, forming the only morphological constituent; which, in water, and still more distinctly on the addition of acetic acid, agglomerated itself into masses composed of larger or smaller globules. Besides these fat-lobules in the most advanced stage of *involution*, and those previously described, only a comparatively small number of lobules in a better state of preservation were visible, and even these contained numerous fat-cells, which had lost their transparency, and were filled with granulous, brownish-yellow, or brownish-red contents (*vid.* "Atrophy of the Fat-cells," fig. 14, *a* and *b*). In another case of *lipoma*, taken from an octogenarian woman, we ascertained the existence of an analogous condition, and thus a correspondence may be perceived with new-formations of connective tissue, in which, also, separate groups fall into a state of involution, whilst the development is continued in others.

Fig. 122.

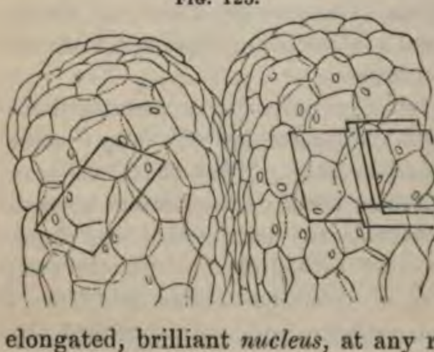
The new-formation of fat-cells never takes place without that of connective tissue, and the consistence of a fatty tumour depends upon the abundance of the latter. When the fat-cells are gradually replaced by a fibrous tissue, a lardaceous growth (*steatoma*) is produced, as has already been stated by Vogel. Fat-cells, moreover, are also met with, imbedded in the substance of tumours composed of immature connective tissue; thus, in a very voluminous *polypus*, as it is termed, of the

uterus, we noticed isolated fat-cells disseminated throughout. They are also seen in the papillary growths of connective tissue, and in their dendritic subdivisions, especially in the synovial capsule of the knee-joint. They are lodged in the cavity of the *papillæ* (Rokitansky's "hollow-clavate *papillæ*"), and appear like longitudinal rows of fat-cells, encircled by connective-tissue-fibres. The rather frequent occurrence of what J. Müller has termed *lipoma arborescens* in the knee-joint, is probably due to the abundance of fat-cells normally contained in the *plicæ adiposæ* of that articulation, just as in the *plicæ adiposæ* of the intestinal *peritoneum*, a seat is afforded for the frequent development of dendritic fatty growths.

VII. CHOLESTEATOMA.

Under this term J. Müller first described an independent kind of tumour, the nature of which, both in respect of its development, as well as of its histological import, is, as yet, not clear. It consists of a capsule, filled with a collection of flattened cells, and limited sometimes to the size of a lentil, or it may even attain to that of a pigeon's egg. The surface of the tumour is uneven, and tuberculated, with a pearly lustre. J. Müller states that by drying, it loses a good deal of its bulk, and, at the same time, its white, waxy aspect, becoming yellowish-brown, but the pearly lustre is not lost, an appearance which he refers to the interference of the rays of light caused by the thin layers, for when the capsular envelope is removed, the *lamellæ*, may be raised like those of an onion. They consist of epidermis-like, polygonal, transparent, pale cells, which, in the case recorded, of a *cholesteatoma* perforating the *dura mater*, and occipital bone, and having a mean diameter of about 0·017‴ (fig. 123), presented an elongated, brilliant *nucleus*, at any rate in most of them, and

FIG. 123.



could be isolated only with difficulty. Between the *laminæ* formed of these flattened elements, were lodged, large cholesterin-plates, together with free fat in the globular form, in some respects not unlike that of the sebaceous follicles. The second kind of crystalline fat, noticed by J. Müller, is more scantily distributed, and occasionally forms little foliated masses; that these crystals were pointed at each end, he satisfied himself, by dissolving them in boiling alcohol or ether, from which they crystallized on cooling. Both he and Rokitansky describe the capsule as a thin, delicately fibrous, or as a structureless, striated membrane.

Cholesteatoma also appears as an accessory growth, associated with other new-formations; thus we have figured it above (fig. 117, *b b*), in *cystosarcoma* of the breast.

With respect to the *development*, it may, perhaps, be assumed as more probable, that the formation of the connective-tissue-capsule precedes that of the epithelial-like cells, than that the contrary takes place. In this case, it might be supposed that a very vigorous growth of these cells occurs in the *areolæ* of a papillary, or more irregular new-formation of connective tissue, and that the cavity is ultimately entirely filled by them; and that, as they are formed in layers from the periphery towards the centre, a concentric disposition will result. The contents of the cyst gradually undergo a retrograde metamorphosis, a view which seems to be favoured by the presence of cholesterin; whilst nothing remains of the papillary formation but a thin structureless pellicle.

Cholesteatoma, therefore, should not be ranked under the new-formations of adipose tissue, its formation depending upon a precedent papillary excrescence. Just as, in the case of *lipoma*, the growth never takes place independently of a new-formation of connective tissue, so is it in the present instance.[1]

[1] [The editor has lately been indebted to the kindness of Dr. Gull for the opportunity of examining a portion of a tumour, about the size of a walnut, from the brain of a lunatic in the Colney Hatch Asylum. It was situated at the base of the brain, so as to compress the *medulla* and *pons*, but, as Dr. Gull was informed, had no connexion with the *cerebrum* and *cerebellum*.

An apparently, precisely similar case is recorded in the fifth volume of the Transactions of the Pathological Society of London, by Drs. Thurnam and Bristowe, and as the account of the microscopic appearances of the growth, given by the latter observer, corresponds in all respects with those exhibited in the case above noticed,

VIII. NEW-FORMATIONS OF CARTILAGE AND BONE.

These new-formations, as J. Vogel has remarked, are so intimately allied, that they cannot, properly, be considered apart. In all new-formations of cartilaginous tissue which have reached a certain stage of evolution, transitional forms of, and even perfect, osseous tissue occur.

it will be sufficient here to transcribe it in part. "The surface had a smooth, white, glistening nacreous appearance, and a considerable degree of toughness; but in the interior these characters were wanting, and the tissue, though white, was soft and lustreless. The superficial, pearly portion was distinctly laminated, and could be split easily into exceedingly thin, but rather tough layers of small size; an imperfect tendency to a like arrangement was visible in the central softer parts, the fragments torn from which assumed the characters of irregular flakes rather than of true laminæ."

Microscopic examination showed, "that the soft internal portions consisted of irregularly polyhedral cells, from about $\frac{1}{400}$th to the $\frac{1}{600}$th of an inch in diameter, interspersed with numerous crystals of cholesterin. The cells were coherent, and modified in shape by mutual pressure. Their contents appeared to be fluid, but certainly not oily, though many of them contained refractive, jelly-like masses [colloid?] of small but various sizes. . . . The cholesterin was external to the cells, and collected more or less into masses.

"The nacreous portion of the tumour was formed of flat, polygonal, cohering epithelial scales, the diameter of which was generally equal to that of the cells above described. They were slightly granular, and each contained a round or oval nucleus about $\frac{1}{2000}$th or $\frac{1}{3000}$th of an inch in diameter, which was remarkably distinct, contained one or more nucleoli, and was surrounded by a transparent zone, against the outer margin of which the granular contents of the cell were accumulated in considerable quantity. . . . In addition to these cellæform elements, from the surface of many parts of the tumour, a delicate layer could be removed, which was structureless, or marked only by delicate and irregular lines, which appeared to be chiefly due to creasing. It seemed to be elastic, and had a considerable general resemblance to the fenestrated membrane of arteries. From the superficial portions of the tumour, all cholesterin was absent, so that the pearly appearance was solely due to the character and arrangement of the epithelial scales."

The above description will amply suffice for the distinguishing of these curious productions, but their genesis is still quite obscure. They are curious, not so much, perhaps, from their contents, which bear a not very remote resemblance to those occasionally met with in sebaceous encysted tumours, whose connexion with the tegumentary system is undoubted, as from their situation, which it would appear is always at the base of the brain, and in the neighbourhood of the *medulla oblongata* and *pons Varolii*. Another remarkable fact connected with them is the circumstance that they appear, hitherto, to have been observed only in lunatics.

Dr. Gull points out the resemblance of these pearly cholesteatomatous tumours with those noticed and figured by Cruveilhier under the name of "tumeur d'apparence perlé," with which they would seem, in fact, to be identical.—Ed.]

It may, perhaps, be regarded as an established fact, that the cartilage-cells, on account of their extraordinary multiplicity of size and form, in themselves bear no distinctive character. Who, for instance, could distinguish the small cartilage-cells in the thick tendons, or those in the synovial processes, and in the *ligamentum falciforme* of the knee, pointed out by Kölliker—from elliptical connective-tissue-cells, or discover any morphological difference between the oblong, fusiform cartilage-cells lying nearest to the *perichondrium*, and the fusiform cells of connective-tissue (Virchow's connective-tissue-corpuscles)? It is not the mere form of the cell that affords its character, but the history of its development. Hence it follows, that in such cases it would be altogether impossible to assign one name rather than another to the cell as such, did not its relative position, to some extent, but chiefly its subsequent metamorphosis into a bone-corpuscle, (Kölliker's bone-cavities) afford evidence that we had to do with a cartilage-cell.

The latest authors agree, if not in the appellation of the cell, still in the main point—that each bone-corpuscle originates in a cell; and the dispute ultimately resolves itself into this, whether under particular circumstances the connective-tissue-cell may become transformed into a bone-corpuscle, or whether there is such a thing as a primary cartilage-cell.[1]

With these few observations, we may now, without risk of being misunderstood, at once define the general process of development in the pathological new-formation of osseous tissue, as one which is preceded by a new-formation of cells, which in their general habit are sometimes cartilage-cells, and sometimes approximate to those of connective tissue.

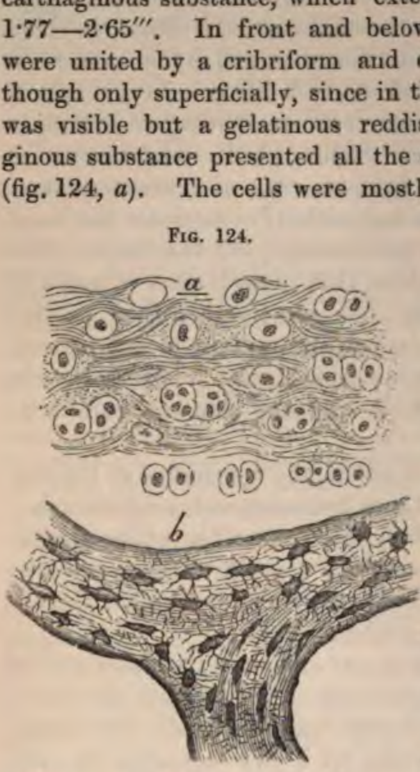
In *fractures of the bones*, the regeneration of the tissue ensues under various modifications, which have not as yet been sufficiently investigated, but which may be surmised from the variation in the mode of development noticed by Sharpey, Kölliker, H. Meyer, and others. We shall first proceed to adduce some well-marked cases from our own experience.

An old woman, three months previous to her death, had suffered a transverse fracture of the neck of the *femur*, close to the head, whose axis formed an acute angle with that of the

[1] *Vid.* Kölliker's 'Manual of Human Histology' (Eng. transl.), vol. i, pp. 81 and 843 (Notes).

femur, and was thus partially broken. At the upper and back part the seats of fracture were superficially soldered by a firm, cartilaginous substance, which extended to a depth of about 1·77—2·65‴. In front and below, the two fractured ends, were united by a cribriform and delicate osseous substance, though only superficially, since in the subjacent layers nothing was visible but a gelatinous reddish material. The cartilaginous substance presented all the characters of fibro-cartilage (fig. 124, *a*). The cells were mostly of an oval form, with a delicate membrane, clear contents, and granular, solitary, or multiple *nuclei* (2—5), which latter had evidently arisen by a process of division, and were accompanied by a corresponding number of protrusions of the cell-wall; the cells were arranged longitudinally with respect to the ends of the bones. The intercellular substance encompassing the cartilage-cells, proved to be of a fibrous nature. The above described cribriform osseous process, consisted of arching and subdividing *trabeculæ*, proceeding from both ends of the bone, and the longitudinal axis of the corpuscles (fig. 124, *b*), was usually parallel with the curve of the *trabecula*. The disposition of the lamellæ, or rather *striæ*, of the intercorpuscular substance, also corresponded with the curve of the *trabecula*, or bony spicule. The substance filling the interstices between the latter resembled connective tissue. The investing cartilage on the head of the bone, was in the normal condition, though partially removed over a space about half an inch in diameter around the insertion of the *ligamentum teres;* the cartilage in that situation appearing, as it were, to be eroded, and the hollow to be filled with a reddish connective-tissue-material,

Fig. 124.



containing considerable, branching vessels, granule-masses, molecular matter, and brownish-red, reddish-yellow groups of pigment-granules. The *ligamentum teres* was in a very soft, infiltrated condition; and the articular capsule was much injected on the inside.

We have observed the process of *ossification of the fibro-cartilage* between the fractured ends of the lower jaw in a Horse. The cartilage-cells, with their granular *nucleus* and the fibrous interstitial substance, at the points more remote from the ends of the bones, were well characterised, whilst in parts nearer the bone a *metamorphosis* began to be apparent in the *nuclei;* the cells lost their granular condition, becoming smooth and prominent, and angular in place of round, or, to use a better expression, minute indentations appeared at the periphery; the *nucleus,* which could still, occasionally, be recognized, ultimately disappeared, and nothing remained but an irregularly-jagged, clear cavity, sometimes furnished with a prolongation (bone-canaliculus). The shape of the bone-corpuscles thus formed, approached the round, oblong, triangular, fusiform, &c.; longitudinal fissures were apparent in the interstitial substance, often constituting entire series (the incipient, fibrous, intercorpuscular substance). Vessels filled with blood appeared to enter the substance of the fibro-cartilage, and in the parts where ossification was commencing they were surrounded with concentric, fibrous layers.

The condition of the cartilage-cells was different in the ossifying cartilage, which formed, with the *periosteum,* a continuous capsule around a comminuted fracture of the *tibia* in a Horse, in which large fragments of bone were enclosed. The cells were small, and of an oval form; the intercellular substance consisted of connective-tissue-bundles, composed of parallel fibrils; the whole presenting a considerable resemblance to the numerous layers of cartilaginous tissue which occur in such a characteristic manner in the thicker tendons in the Horse. It is obvious, that in order to see the delicate cartilage-cells, extremely thin layers of the tissue must be viewed, for otherwise they would be concealed by the connective-tissue-fibres. The metamorphosis of the cells could not be observed as in the former case, since, in many situations, the cells imbedded in the intercellular substance already appeared as angular, pale

corpuscles, with merely an indication of a *nucleus*. On the other hand, it was evident, that the intermediate connective-tissue-fibrils had disappeared, and been replaced by a lumpy, streaked, and ultimately, as it were, mottled (auftapirten) interstitial substance, in which the young bone corpuscles could be recognized only in extremely thin plates. Where the osseous tissue was perfectly formed, the corpuscles appeared slenderer, oblong, and jagged, and the interstitial substance presented the well-known finely porous aspect. In this case no complete medullary canals had been formed; there existed, it is true, narrow, closed spaces, filled with a fine-granular, yellowish-brown material, which gave the thicker sections a spotted appearance, but none were observed filled with blood.

From these observations it follows: 1, that a formation of cartilaginous tissue (or, if this term be objected to, a formation like connective tissue) precedes that of the bone, in the regeneration of the latter; 2, that the form of the cartilaginous tissue varies; 3, that the regeneration commences from the *periosteum*, and that a perfect new-formation of bone may, there, have been attained to, whilst in the deeper layers, sometimes the products of exudation, sometimes, in compound fractures, dead portions of bone are found; 4, the material known under the name of *callus* consisting essentially of fibro-cartilage, surrounds the broken ends of the bone, and is equivalent to Dupuytren's provisional *callus*.

It is a well-known fact that the ossification continues to advance towards the centre of the bone, and ultimately fills up the medullary canal; but, under these circumstances, it is not a compact substance which is produced, but merely one of soft consistence, with bony *spicula* and comparatively large *cancelli* which abut upon each other in the centre. The continuity of the medullary canal is subsequently restored, but the precise mode in which this is effected demands further research.

In fractures, the exudation is, often, only partially organized, or not at all. The formation of fibro-cartilage takes place only imperfectly, or, as it would appear, in many cases is wholly abortive, the union being effected, chiefly or solely, by a fibrous substance. If *pus* be produced from the exudation, the curative process is impeded, either throughout or in circumscribed portions, and it not unfrequently happens that an abscess is formed,

together with an excessive development of bone on the part of the *periosteum*, in the form of various kinds of osseous growths. The portions of bone bathed by the *pus* necrose, and may, when the suppuration has ceased, and the new bone has advanced from the neighbouring parts, give rise to the formation of a *sequestrum*. In a histological point of view, we cannot speak of the union of a fracture by suppuration, inasmuch as the *pus* is a new-formation, which, so long as it remains, opposes the union.

When the fracture is perfectly united, the line of junction is indicated on the surface of the bone, by a more or less raised, osseous swelling; but the subjacent tissue is less compact than elsewhere, as may be seen in sections. A perpendicular section through an osseous cicatrix, the direction of which was downwards and inwards, in the inferior fourth of the *tibia*, displayed, above the seat of union, a dense texture appearing white by reflected light, and which was abruptly defined from the yellowish connecting substance. The former, by transmitted light, exhibited a grey, compact tissue (fig. 125, *a*), in which the medullary canals, divided transversely and obliquely, were of comparatively small size, whilst the latter (*b*) presented a wide-meshed, delicate network of osseous rays, retaining their usual transparency. The substance with which the *cancelli* were filled was opaque, amorphous, and infiltrated with fat. Towards the curved surface, a more compact *cortex*, with narrower *cancelli* was perceptible (*vid.* the convex border in the figure); but in general a lax, spongy texture was characteristic of the connecting substance.

Fig. 125.

The cure of injuries of the bones, accompanied with loss of substance, is tedious and difficult, as is shown, especially, in the openings made with the trephine. In a very instructive case of a considerable loss of bone in the middle of the *os frontis*, resulting from a severe fall, and a subsequent operation with the trephine, Vrolick has endeavoured to show that new cartilage- and bone-substance may be formed from the

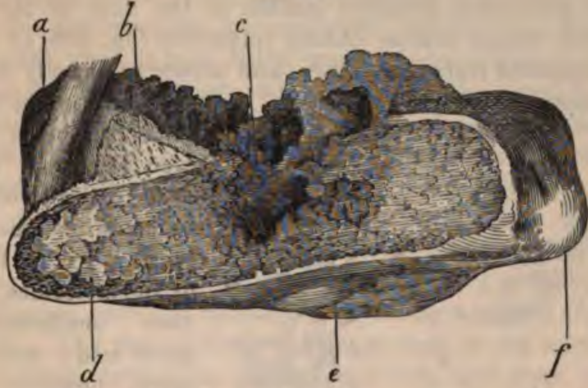
exudation afforded by the edges of the wound, independently of the *dura mater* and *periosteum*. After the removal of both membranes, there remained a cartilaginous substance, which filled nearly the whole of the opening, and in which could be perceived larger and smaller systems of bony *spiculæ*, none of which were connected with the osseous borders of the opening. But from this, it by no means follows that the *periosteum* is not concerned in the restoration of the bone, in which, on the contrary, it would appear, from the researches of B. Heine, to play the principal part. Günsburg describes the appearances presented in the *cranium* of a woman who had survived the operation of trephining for 79 years. The opening in the bone was closed, on the inner aspect, by a membrane perforated in several places, and the edges were there united with a deposit arising from the *dura mater*. The membrane consisted of flaky structures, and decussating fibrous bundles, which were attached to the thinned and contracted edges of the bone.

The new-formation of cartilage, and its transition into osseous tissue, may be very distinctly observed in the tumours termed by J. Müller "*enchondromata*," on which account we shall, here, proceed to notice them.

An *enchondroma* of the *femur*, nearly as big as a child's head, was amputated by Professor Schuh. The tumour was distinctly defined, lay in the continuity of the bone, arising above the condyles, which retained their form in all its integrity, and extended above the middle of the *femur*. After the soft parts had been removed, the tumour appeared elliptical, with slight, tuberous elevations on its smooth surface; it was of a yellowish-grey colour, speckled with red, of a dense consistence, and covered with a shining, adherent coating. When cut, a dirty, bloody, glutinous fluid escaped, mixed with gelatinous, friable masses, which had been detached from the inner side of the large, thick walled, sinuous cavity. These gelatinous masses constituted, for the most part, the lining of the inner wall, and were, also, occasionally more consistent, projecting in the form of warts and clavate processes. An oblique section across the *femur*, which was bent at an obtuse angle, afforded the following results. The thick wall (fig. 126, *a*) of the *sac*, which extended upwards, and whose inferior extent is seen at *e*, exhibited, at its point of connexion with

the compact osseous substance, numerous jagged projections, which gradually passed into an *osteophyte*, displaying, in the

FIG. 126.



section, a triangular form (*b*); the smooth surface of the latter, constituting the segment of a circle, was applied to the wall of the cyst (*a*), projecting, with its irregular processes, towards the brownish, soft, cartilaginous investing substance, which, at *c*, assuming a flesh colour, had supplanted the compact osseous tissue of the *femur*. A bluish-grey, greyish-yellow mass, with a lobular border on one side (*d*), was lodged in the substance of the latter; at the lower part, towards the condyle (*f*), and especially at the point where the growth had perforated the bone (*c*), the substance presented a fleshy-red colour, and extended still further until it reached the compact *cortex*.

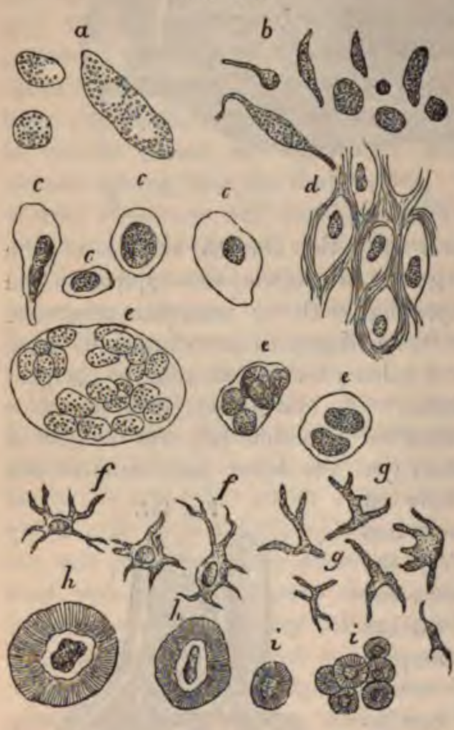
FIG. 127.

Precisely analogous, cartilaginous deposits were observed in the same limb at the inferior, enlarged extremity of the *tibia*, in whose spongy substance, and deep-red *medulla*, the bluish-grey, or greyish-red cartilaginous growth (fig. 127, *a a*), was apparent, well defined by its lobu-

lated contour. Similar cartilaginous masses occurred also in the bones of the *tarsus*, and in the first phalanx of the great toe, situated in the spongy tissue of the enlarged articular ends.

The gelatinous, detached masses, in the fluid of the cyst, contained round, oval or oblong corpuscles (fig. 128, *a*) which were separated from each other, and presented sharply defined molecules, and one, or even two, hyaline *nuclei* in their contents; the latter, however, were not visible in the majority of these elementary bodies, appearing to be hidden by the molecules, which were unaffected by acetic acid; which reagent, however, produced, a considerable turbidity in the fluid (mucin-filaments.) In other situations, again the elements presented great varieties of form and size, as at *b*; the intercellular *stroma* was sometimes perfectly hyaline, sometimes indistinctly granular. The less transparent, deeper-coloured masses consisted of a dark brownish-yellow molecular substance, aggregated in larger or smaller quantities, in which were occasionally imbedded very large fat-globules, some of which might also be seen floating on the surface of the fluid. Besides these elements, there were visible, granular, agglomerated *nuclei*, and elements resembling shrivelled blood-corpuscles, together with detached, wavy connective-tissue-bundles. The same results were afforded by the examination of the gelatinous substance attached to the bulging inner wall of the cyst. The papillary, wart-like

FIG. 128.



projections were more consistent, less transparent, and composed of variously shaped cartilage-cells.

The outer layer of the enchondromatous sac was formed of a dense fibrous tissue, with elastic filaments and blood-vessels; when this was removed, the opalescent, cartilaginous substance came into view, whose cells, encircled by fibres, were less distinct at the periphery, whilst towards the interior, they presented the unmistakeable character of cartilage-cells, as, for instance, from the costal cartilages. In other parts, and more internally, manifestly embryonic formations were visible in the thick wall. Other elementary bodies were observed, of polymorphous shapes, and consisting of a delicate membrane, with clear, transparent contents, and enclosing a round, oval, or elongated, granular corpuscle, resembling a *nucleus* (fig. 122, *c c c c*). The size of the envelope, as well as the number of the enclosed corpuscles, increased (*e e e*), and they became aggregated into separate masses within the tunic.

In the further examination of the outer layers of the sac, ossified portions were noticed, connected, partly with the evidently cartilaginous tissue, partly with bundles of fusiform fibres. The bone-corpuscles were either very clear, and finely jagged, or opaque, with fatty molecular contents; the inter-corpuscular substance was, for the most part, finely striated.

The transverse section of the *femur*, when closely examined, showed the *cancelli*, occasionally of considerable size, and filled with a cartilaginous substance, which had replaced the osseous *trabeculæ* with groups of more or less well defined and removable nodules or *papillæ*. This new-formation contained fibro-cartilage-cells, with granular *nuclei*, not unfrequently in a state of incipient division (fig. 128, *d*); dark streaks, also, could be seen, crammed full of collections of fat-globules, unalterable in acetic acid, and surrounded by oblong or fusiform cartilage-cells, imbedded in a hyaline *stroma*. A considerable degree of interest attached to certain elementary structures, consisting of a body, with three, four, or more radiating processes, and containing in the centre a granular *nucleus* (*f f*); which latter, however, was wanting in many other similar elements (*g g*). There were also groups of bodies having a rounded outline, and of various dimensions, exhibiting, in the centre, a cell (?) with hyaline contents, and

presenting at the periphery a radiated striation (*h h*); in the smaller bodies of this kind, there was simply a granular central mass, with radiating *striæ* abutting upon it (*i i*); the outline was less sharply defined than it appears in the figure.

Very numerous varieties of cartilage-tissue were met with in all parts; for instance, rounded cells, disposed in groups or rows, with a large, granular *nucleus*, and an indistinctly molecular, or perfectly structureless intercellular substance (fig. 129, *a*), which, in other places, presented a lamellar texture (*b*). Close to the larger osteophyte (fig. 126, *b*), elementary organs occurred in the cartilaginous layers (fig. 129, *e*), surrounded with a distinct membrane, and enclosing a granular, occasionally radiated corpuscle, and which evidently stood in close connexion with the osteophyte, containing light and dark bone-corpuscles in a streaked intercorpuscular substance (*f*).

Fig. 129.

The *medulla*, close to the site of the amputation, was injected with blood, contained numerous, stellate groups of crystals in its fat-cells, and, lower down, was entirely replaced by the enchondromatous substance. The muscles presented a gelatinous, pale aspect, and loose texture; and, when torn asunder, the primitive *fasciculi* exhibited the same appearances as may often be observed in those of Amphibia or Fishes in the recent condition, when the muscles have been slightly squeezed or torn; that is to say, the cross *striæ* were no longer visible, nothing being seen but transverse *rugæ* (fig. 129, *c*), and occasionally a longitudinal striation, corresponding to the primitive fibrils. When the primitive *fasciculi* were torn, they sometimes appeared to be connected (as at *d*) by a hyaline structureless band. It cannot, perhaps, be doubted that the proper muscular parenchyma had, in this instance, undergone a process of fusion, in consequence

of which, it had been reduced to the condition of a viscous fluid, which could be drawn out of the sheath in the form of the hyaline band (*d*); and it is most probable that the *rugæ*, above noticed, were due to transverse folds of the *sarcolemma*.

It still remains to speak of the histological import of several of these elementary organs. The cells, fig. 128, *e e e*, must, perhaps, be regarded as parent-cells, with secondary cells enclosed in them, but, in this case, it should be remembered that the former have scarcely any longer the functions of true cells, and that, although the tunic may grow, they are incapable of further multiplication by division; they might, consequently, be looked upon as intermediate agents in the nutrition of the secondary cells, towards which their relations would not be unlike those of the nutritive capsule of one or several *Echinococci* or *Cysticerci* towards the animalcules. The branched elements, described by J. Müller as jagged corpuscles (fig. 128, *f f*, *g g*), had probably an investing tunic (as at *e*, in fig. 129), but which, on account of its tenuity, was not distinctly visible, and the rather so since the corpuscles in question were imbedded in the tissue. J. Vogel remarks that they resemble bone-corpuscles, with which they are, without doubt, related, as is rendered more evident by the researches of Kölliker and H. Meyer, with respect to the development of the pore-canaliculi. But the corpuscles, *h h*, *i i*, in fig. 128, admit of a more doubtful interpretation; and it has to be determined whether the larger specimens contain a cartilage-cell in the centre, and have suffered radiating fractures at the periphery, or whether those marked *i i*, in particular, do not represent colloid corpuscles.

With respect to the development of the above-described *enchondroma* of the *femur*, it may be assumed, with a considerable amount of probability, that the new-formation sprung from the periosteum, and consequently was, at first, a peripheral *enchondroma*, or, should another name be preferred, a cartilaginous *sarcoma*, and that it did not, till subsequently, become a central *enchondroma*, by the deposition being continued into the *parenchyma* of the bone. This may be supposed from the circumstance that such a compact and large osteophyte was seated on the surface of the *femur*, and as it is difficult to conceive how, after the perforation of the compact

cortex of the bone, on the part of the already softened cartilaginous tissue, such a bulky tumour should have been formed. The *enchondromata* in the *tibia*, and both the others, are central.

In several other *enchondromata*, from the spongy portions of the long bones, and of the lower jaw, cells in close apposition, with a very small quantity of fibrous interstitial substance, and with rarefied parent-cells, were chiefly noticed, an observation corresponding with those of Joh. Müller. Not unfrequently, also, softer, yellowish spots, with a lustre not unlike that of *asbestos*, were observed, containing merely a collection of *nuclei*, with numerous, often fatty, molecular masses, and representing abortive forms, such as are displayed in most new-formations. According to Virchow's nomenclature, these portions would be said to be in a state of tuberculization.

The new-formed cartilaginous substance is frequently interrupted by interposed connective tissue, and the greater the predominance of the latter, the more does the *enchondroma* lose its proper character, and acquire that of a *sarcoma*. We had an opportunity of examining a growth of this kind. The tumour was situated external to the *testis* and *tunica vaginalis*, but intimately and inseparably united with the former. In the centre was a cavity, at least as large as the fist, containing a thick, yellow fluid, and lined with a firmly adherent, yellow coating. The wall of the cyst was, in many parts, more than an inch thick, whilst, where it rested on the *testis*, its thickness was not more than two lines. A multitude of smaller cysts were imbedded in the tissue of the sac, some very minute, others as big as a walnut. The larger ones contained the same thick, yellow liquid, and a few of the smaller enclosed a transparent wine-yellow, glutinous fluid. Lastly, small tuberous elevations, of an opaline aspect, might be noticed, which, on section, displayed cartilage-cells, sometimes isolated, sometimes assembled into groups of three or four together; these cells contained more or fewer brilliant molecules, with a *nucleus* rendered manifest by acetic acid, and they were round, oval, elongated, fusiform, or represented the segment of a circle, or of an ellipsoid. The ossified parts were well defined, and penetrated, in the form of digitate processes, into the cartilaginous sub-

stance, giving off, as they proceeded, jagged, osseous rays, like those which are seen in the ossification of the cranial bones of the *fœtus*.

In describing the first case of *enchondroma*, it was stated that the new-formation of cartilage might take place on the free surface of a cavity in the *clavate* or *verrucose form*. This appears to us to have been the case in the instance now cited of *cystosarcoma* of the *testis*. Instead of a papillary new-formation of connective tissue, we find a similar formation of cartilaginous tissue, arising from the growth of cartilage-cells in successive layers, circumscribed laterally.

Precisely analogous new-formations of cartilage-tissue occur, as is well known, in *cancer*, which we shall afterwards notice; in this case, as in *sarcoma*, they are simply accessory formations, and do not affect the essential nature of the tumour.

J. Vogel has correctly observed, that the outward form and aspect of a tumour should never be held sufficient for its determination, from such characters alone, as an *enchondroma*. Microscopic examination only can afford a certain diagnosis, and prove that we have to do with a cartilaginous tissue. We have already, on several occasions, remarked, that callous, and particularly colloid exudations, as, for instance, on the *pleura*, *peritoneum*, middle coat of the vessels, &c., deceptively resemble cartilaginous tissue, though containing not a vestige of a cartilage-cell.

The *ossification of enchondroma* has been more particularly described by Rokitansky; he distinguishes that which results in the formation of a very dense, hard, ivory-like bone, from that which produces a dull white, very dense, though friable, coarsely granular, osseous substance. In the former case, he found the bone-corpuscles furnished with very few and short processes, and larger, though not uniformly so, than in normal bone, of a coarse shape, and in their disposition showing some indications of regularity. The lamellar texture is limited to a flaky or foliated parting of the *stroma*, in one or other of the rings surrounding one of the medullary canals, which are scanty, and run in all directions. In the second form, the process of ossification is incomplete, being confined, in many places, merely to the deposition of calcareous salts.

An *excessive new-formation* of embryonic cells may take place in the *cartilaginous tissue*, in consequence of which it is rendered very soft, homogeneous, and compressible. Thus, in the soft, white, intervertebral cartilages, readily splitting into several parcels, taken from the lumbar spine of a rachitic individual, 24 years old, we found that the affected substance had lost its normal transparency. In the dissection, isolated, nucleated cartilage-cells, and rounded, or irregularly angular, granular corpuscles escaped in great abundance; sharply defined, elliptical bodies, of considerable size, were also noticed, containing a larger or smaller quantity of the above-mentioned granular corpuscles (fig. 130, *a*, *c*), which were imbedded in a fine-molecular and structureless *matrix*, or were sometimes wanting altogether, nothing remaining in the cavity but a granular substance; but they also occurred singly in smaller vesicular structures (*b*). Whether they were all of the nature of *nuclei* may well be doubted, inasmuch as they appeared to be far too numerous; they might, therefore, at any rate, in part, be regarded as secondary cells. That these presumed cells, like the *nuclei*, entirely fill the parent-cell by their rapid multiplication, is a fact; and that a rupture of the tunic may thence ensue, there is every reason for supposing. Larger groups of cartilage-cells, were likewise apparent, separated from each other by arching, fibrous bands (*d*). The cells, of considerable size, enclosed one or several *nuclei*. Other elementary organs were also worthy of notice, presenting a concentric striation (*b*), and arising probably in a successive condensation of the colloid cell-contents.

Fig. 130.

The first stage in the development of the cartilage-cell, appeared to be the formation of a hollow vesicle, in which, commencing on one side, a differentiation into two subdivisions was

apparent—a hyaline pale globule being formed on the one side (vesicular nucleus), and on the other a crescentic deposit. The *nucleolus* did not make its appearance in the vesicular *nucleus* till afterwards, and, perhaps, two might be seen, like distinctly projecting granules.

In the fibrous, homogeneous articular cartilages, in accordance with the statements of Ecker, Kölliker, and Redfern, we have also observed voluminous parent-cells with one, two, or many secondary cells; and besides these, cells in a state of fatty degeneration are always met with. In this case, also, a new-formation of embryonic connective tissue may be noticed on the one hand, together with a retrograde metamorphosis on the other.

After a loss of cartilaginous substance, it is never replaced, the hollow being simply filled up by connective tissue; or a cretification of the entire cartilage may take place, as shown by the experiments of Dr. Redfern on animals.

In the papillary new-formations of connective tissue in synovial membranes, new-formations of cartilage-cells may develop themselves in the hollow *sacculi* noticed by Rokitansky. These growths are aggregated, especially at the line of insertion of the articular capsule;—they are thick-walled, usually enveloped by a fibrous tissue, and become ossified. According to Rokitansky, these ossifying new-formations, when of larger size, lose the form of rounded masses seated upon simple or branched peduncles, and necessarily accommodate themselves to the normal articular structures, as well as to any kind of new-formation already existing; they present, especially in the space between the articular capsule and the condyles, an even or sometimes slightly convex, sometimes slightly concave articular surface, and besides this, where they come in contact with others, several facets; when in considerable numbers, Rokitansky has seen them assuming the form of prismatic cones. He found that these new-formations were enclosed according to circumstances, sometimes in a thinner, sometimes in a thicker membrane, composed of connective-tissue-fibres, and that they were invested on their articular surfaces with a layer of cartilage with a fibrous intercellular substance, which is sometimes wanting, so that the osseous substance is exposed. Occasionally, also, he has noticed on them, even on their

articular surfaces, other vegetations; their basis is usually formed by the meeting of several flattened bands, which converge from various points. He has no doubt, moreover, that these growths occasionally become detached, when they constitute a particular form of loose cartilage in the synovial cavity.

What is termed *malum coxæ senile*, an appellation to which Rokitansky and Wernher object as inappropriate, since this form of disease does not occur exclusively in the hip-joint nor in old age, has been variously understood by different authors of late times. Whilst Wernher describes the essence of the disease as consisting in an inflammation of the coxal muscles, and regards the pathological changes in the corresponding bones as secondary, Zeis places the inflammation of the hip-joint, in the first place; but both authors have overlooked an essential circumstance, adverted to by Rokitansky, viz., the growth; 1, of vegetations from the spongy part of the articular head, in consequence of which the investing cartilage becomes filamentous or felty, and its intercellular substance split up into fibres; 2, of botryoidal, knotty, osseous growths, covered by cartilage in the recent state; and 3, of similar osseous growths around the cartilaginous articular surfaces. We regard these new-formations of cartilage and bone-tissue as so essential to the present disease, that they must be considered as forming part of it.

But it should not be overlooked, that an exudative process is going on at the same time, not only in the articular capsule, but also in the medullary substance of the spongy tissue in the affected head of the bone, accompanied with a hypertrophy of the bone-corpuscles, and of the so-termed osseous *lamellæ* (*osteosclerosis*). Thus we perceive, in this case, that three different processes are combined together. Whilst the new-formation of cartilage and bone-substance proceeds at certain points at the periphery of the spongy part of the head of the bone, inducing a secondary atrophy of the investing cartilage, the exudation is causing in other parts a fusion of the osseous tissue, and an apparent enlargement of the *cancelli*, which are infiltrated with an exudation in a state of involution, constituting what is termed inflammatory *osteoporosis*; whilst at a third poiut, hypertrophy of the bone is apparent.

In consequence of a more vigorous nutrition of one or other

part of the bone, there is produced, in the so-termed *malum coxæ* and analogous affections, a lamellar multiplication of the bone-corpuscles, which, of course, are derived from cells. In this way the medullary canals and *cancelli* become diminished, as is proved by direct observation in parts of bone in a state of *sclerosis*. But the increase of the osseous substance, when it exceeds a certain limit, reached at the expense of the nutritive vessels contained in the *cancelli* and canals, necessarily leads to the involution of the hypertrophied parts. In the *cancelli* also, may be noticed numerous amorphous deposits of calcareous salts; the spotty, unsymmetrical, and close distribution of which, conveys an impression as if these deposits took place in the bone itself. We have also noticed deposits of fatty matter and pigment, which could not be removed by acids, in the osseous substance of sclerosed portions of bone in a state of incipient involution; and the latter may present irregularly disposed, frequently, aggregated, closely crowded bone-corpuscles, varying in size and form, and manifestly indicating a rapid new-formation. If reiterated exudations now ensue around the sclerosed portion in a state of involution, the texture becomes loosened up, or passes, as it is usually expressed, into a state of *osteoporosis*.

The deposition of calcareous salts is very abundant in the well-known porcellanous substance on the diseased head of the bone, and contributes, next to the botryoidal new-formations, to the atrophy of the articular cartilage.

The same process as that which we have described as occurring in the articular head, may also take place in the *acetabulum*, whence arises a more or less complete *synostosis*. The true osseous connexion between the two parts of the joint—the concave and the convex—is effected by the new-formations growing on each surface. In the intermediate osseous substance, comparatively large *cancelli* and canals are formed, usually filled with an opaque, amorphous material, yellowish-white, or dark coloured, when viewed by direct light.

In the form of disease, known under the name of *coxalgia*, an excessive exudative process, which gives rise to the new-formation of *pus* and connective tissue is succeeded by that of bone. In a man, 29 years of age, affected with acute *tuberculosis* of the *meninges* at the base of the brain, and in the

lungs, the left *acetabulum* was bare of cartilage, full of warty osteophytes, and the *ligamentum teres* destroyed by a pulpy exudation, so that its texture could no longer be recognized; the head of the *femur* was only partially covered at the border, with a thin, loosely attached cartilaginous layer, beneath which was a lobulated, soft new-formation, springing from the *cancelli*, and by which the loosening of the cartilage had been caused. A vertical section of the head disclosed a greyish-yellow, nodular mass (bone-tubercle), about 1·32‴ in diameter, which consisted of mere nuclear formations, analogous to the grey tubercular substance in the lungs. The medullary substance was in patches, deeply reddened, and contained, in many places, embryonic connective-tissue-formations, in a state of fatty degeneration. The cellular tissue on the *cervix femoris* was pulpy, and infiltrated with a gelatinous matter, without any visible formation of new elements; the connective-tissue-fibres and the elastic filaments, appearing to be forced asunder by the gelatinous exudation.

It has long been satisfactorily shown, that no strict limits can be drawn between *exostoses* and *osteophytes*. Engel has laid particular stress upon the genetic impulse, stating that the former are produced by an increase of the osseous substance without inflammation (= hypertrophy), and that the latter are the product of inflammatory action, notwithstanding the existence of the most various transitionary forms. With reference to what has already been stated on the subject of exudation, atrophy, and hypertrophy, we would, here, remark, from a histological point of view, that an *exostosis*, regarded as a partial hypertrophy of authors, is an excentric growth of the osseous substance, limited to a certain part, and following the type of the portion of bone affected, whilst an *osteophyte* represents a new-formation of osseous tissue, either not arising from any bone at all, or not conditioned according to the type of the part of the bone affected. But if the latter is ill defined, the criterion is, of course, deficient, and exostoses and osteophytes cease to represent distinct ideas.

If we suppose, that from any circumstance, more nutritive matter is afforded to a portion of the *periosteum*, or of a superficial part of the bone, circumscribed by the mode in which its vessels are distributed, the parts concerned will necessarily, in case an

active organizing *nisus* is set up, experience a more vigorous nutrition, that is to say, systems of bone-corpuscles are deposited, which, however, do not in the direction of their growth differ essentially from those of the original system (*vid. sup.*, "exostosis at the root of the teeth"), but are to be regarded, as it were, as adventitious, superimposed systems, which in their further development are even provided with medullary canals. In fig. 131, we have represented a perpendicular section of a perforated parietal bone. Posteriorly, the bone was perforated by an opening having a circumference about that of a middle-sized chestnut, whose borders were callous and thickened, and on the vitreous table, both there and in several other situations, were deposits of flattened, finely jagged, bifurcating bony masses; *a a* corresponds with the outer side, which is, as usual, more compact, pervaded by smaller medullary canals, and less transparent than the central osseous substance occupying the spaces between the thicker canals of Breschet, and the *cancelli* (*b*). On the vitreous table is seen the divided, bony deposit (*c*), with tolerably wide medullary canals, anastomosing with those of the *diploe*. The transparency was again diminished in the denser, internal layer of the new formed substance.

Fig. 131.

Now, should the growth in question be termed an *exostosis* or an *osteophyte?* Did it arise from an inflammation, or from an atrophy? Is the type of the affected bone retained? In answer to which we think it necessary merely to put the two questions: Where does hypertrophy cease, and where does inflammation commence? when can it be determined that the type is changed? It is obvious at once, that, in entertaining questions like these, we become involved in a maze of subtleties, and are wearying ourselves in the making of distinctions which do not exist in nature. It is far rather incumbent on us to ascertain the development of new-formations of this kind.

Opportunities are often afforded of tracing the development of the structures denominated by Rokitansky "puerperal

osteophytes;" from which term, however, it must not be supposed that the formation is limited to the puerperal state exclusively. A similar formation of osteophytes on the inner surface of the *cranium*, is witnessed under other circumstances, as has also been remarked by Engel, especially, in *tuberculosis*. The osteophyte in question is formed by the nutrient vessels of the *dura mater*, which also penetrate into the vitreous table, through small openings, which may be distinctly perceived in the macerated bone. Now, as the greater number of these vascular orifices are situated at the borders of the sutures, of the groove for the *a. meningea media*, and along the longitudinal *sulcus*, it is easy to comprehend why those situations are the principal seats of the new-formation. An exudation takes place from these vessels, in which may, at once, be noticed, together with an amorphous *blastema*, an organized substance, in which Virchow has remarked immature connective tissue (caudate corpuscles), or an apparently homogeneous, scarcely fibrillated connective tissue, with numerous, parallel, oval *nuclei*, together with very many intercommunicating, newly formed vessels, which are readily torn when the delicate layer is raised from the bone. In deeper layers, he has usually noticed the rapid development of a perfectly homogeneous connective tissue, often presenting no trace whatever of fibrillation, and in which, after treatment with acetic acid, *nuclei* can but rarely be rendered visible, but which is always perforated by good-sized openings for the passage of the vessels. Of cartilage, he was never able to perceive any trace, nor of cells, beyond the fibre-cells of the immature connective tissue. He is of opinion, therefore, that if the bone-corpuscles have any genetic relation with a pre-existing portion of the tissue, it can only, from what he has seen, be with the *nuclei* of the connective tissue.[1]

In recent preparations, we have directed our attention to the *cancelli* formed by the arching *trabeculæ* of the osteophyte, and traced the fine osseous *spiculæ* to their outward termination; and have thus been able to satisfy ourselves of the existence of a very delicate layer of oval, nucleated cells, placed at tolerably regular distances apart, and imbedded some-

[1] [*Vid.* Note, Kolliker's 'Manual of Human Histology' (Eng. trans.), vol. i, p. 81.—Ed.]

times, in an amorphous, sometimes, in an indistinctly striated *matrix*. A little nearer the ossification, the rounded outlines of these cells are still very easily distinguishable (fig. 132, *a*), and there is very often apparent in them a space, sometimes central, sometimes placed towards one side, which can scarcely be explained as a *nucleus*, but as a cavity in process of development, or as Rokitansky, from the examination of the process of ossification in rachitic bone, has remarked, is to be ascribed to a retraction of the cell-contents towards the *nucleus*. In the parts thus undergoing ossification (*a*), the intercellular substance presents a finely punctated aspect, and the osseous *canaliculi*, which mostly penetrate the bone in an oblique direction, are already perceptible as minute fissures. The intercellular substance, therefore, would seem to exhibit minute hollow passages, even before the formation of an indented bone-corpuscle.[1] Besides this, two openings will be observed in the figure (*a*), destined for the passage of vessels.

Fig. 132.

Thus, we may perceive the greatest analogy between the formation of the fœtal cranial bones, and that of osteophytes seated on the vitreous table, and deduce the origin of the spherical bone-corpuscles from the rounded cells; our observations, in all other respects, with this exception, being in accord with those of Virchow. Like him, we have also noticed places, in these osteophytes, in which the above-described layer of oval cells appeared to be wanting, nothing but fibre-cells being met with next to the ossified part; but whether these belonged to the connective tissue, cannot, as we conceive, be decided from their shape, but from the transformations they undergo. The bone-corpuscles, also, in these situations, were of an oblong form (fig. 132, *b*), and appeared quite clear and somewhat jagged. Even to the naked eye, but still better with the aid of a *lens*, in these striated osteophytes, nearly parallel grooves could be perceived, which were apparent even in extremely

[1] *Vid.* Kölliker, op. cit., vol. i, p. 361, note.

thin *lamellæ* taken from them (as in *b*). The bone-canaliculi, also, running in an oblique direction, were surprisingly numerous in these osteophytes. The roundish bone-corpuscles were proportionately of large size, having short, tooth-like processes at the periphery, and closely approximated to each other; and the interstitial substance never seemed to us so finely striated as it appears between the oblong corpuscles, especially after treatment with hydrochloric or acetic acid.

In skulls that have been macerated, these osteophytes, on the smallest scale, seated on the vitreous table, appear like just perceptible, white scales, which can be readily removed, and of a soft, friable consistence; and by the inexperienced observer, they might be taken for mere calcareous concretions, the opaque substance apparently exhibiting no structure. But the application of acetic acid removes all doubt that they consist of true osseous tissue, for when the substance is rendered transparent by the removal of the earthy salts, the clear bone-corpuscles become visible. The usually discrete, white scales are seen, in other situations, spread over an extensive surface, and coalescent; and in like manner they unite to form successive layers, finally constituting compact osseous plates, which, after the skull-cap has been removed, occasionally remain attached to the *dura mater*, and in thin sections exhibit chiefly oblong, many-rayed bone-corpuscles interlaced with each other in variously formed groups. The intercorpuscular substance in one preparation was penetrated by very distinct, freely anastomosing bone-canaliculi, which appeared as if they had independent walls. The medullary canals in the denser osteophytes are always well developed, forming a delicate network of tubes, in which the anastomosing branches gradually diminish in size as they approach the central point of union.

Those osteophytes are, in many respects, of considerable interest, which occur on *serous membranes*. Morphologically, they differ from the above, chiefly by their papillary, globose, or clavate projections towards the free surface. Several wart-like osteophytes, seated on the arachnoid, near the *falx major*, projected inwards towards the sac of the arachnoid, varying in size from a scarcely visible nodule to that of a lentil. In the larger specimens, several botryoidal elevations could be per-

ceived, even by the naked eye, distributed over the whole surface. Under a low magnifying power, and by reflected light, a multitude of globose, clavate, or conical tuberosities, with lateral nodosities, and clearly defined, could be perceived (fig. 133), the surface of which appeared smooth. These nodulated growths precisely resemble, in their configuration, the analogous productions of connective tissue, such as we have figured, for instance, from *cystosarcoma* of the breast (figs. 117, 118); and which are met with in *sarcoma* and *cancer*, projecting into the *areolæ* in the form of cartilaginous vegetations.

Fig. 133.

It is not difficult, in carefully prepared sections of these ossified vegetations, to satisfy oneself that they possess the texture of bone. The bone-corpuscles are disposed according to the outline of each projecting nodule, in lamellar series, and may also, in many places, be concealed by the opaque, brownish-yellow and brownish-black intercorpuscular substance, and these parts may very suitably be compared with new-formed *papillæ* of connective tissue in a state of involution. These ossified vegetations, when they have reached the height and breadth of a few millimeters, also possess a system of medullary canals (fig. 134), presenting the usual characters, viz., a more or less rectilinear course, the meeting of several branches in a saccular dilatation of the canal, and the junction of the branches into a wide-meshed network. Whether these canals penetrate into the papillary excrescences we have been unable to determine, though we doubt the fact

Fig. 134.

of their doing so; whilst in recent osteophytes of this kind we have noticed a distinct vascular *plexus* in the furrows on the surface.

We have examined the more intimate textural conditions, and particularly with reference to the disposition of the bone-corpuscles of the nodular excrescences, in osseous plates, which were found by Dr. Türck in the visceral *lamina* of the arachnoid, on the thoracic portion of the spinal chord. The *pia mater* was there covered with a thick, puriform layer, 0·78—0·11″ thick, extending upwards as far as the superior thoracic *vertebræ*, which were so far destroyed by *caries* that in some of them no part of the body was left. One smaller and two larger osseous plates were observed, each of the latter having a longitudinal diameter of 0·23—0·27″, and a breadth of 0·15″. At their points of attachment they appeared smooth and firmly imbedded in a fibrous *stroma*; on the free surface, botryoidal elevations, similar to those of the osteophytes just described, were perceptible. A portion of these excrescences, removed by the scissors, retained sufficient transparency to allow of the structural details being made out. The peripheral outline was well defined, presenting numerous sinuous protrusions (fig. 135).

Fig. 135.

The shape of the excrescences was characterised by its multifariousness, being globose, nodulated, papillary, &c. The bone-corpuscles, which were mostly oblong and light-coloured, were disposed at regular intervals, with their longer diameter pretty nearly parallel with the outer surface of the growth. The intercorpuscular substance presented a well-marked striated texture. The bone-canaliculi were seen in the surface exposed by the scissors (at *a*), at which point the growth was connected with other similar excrescences.

We have also noticed an incipient ossification in a *cartilaginous shell* covering the convex surface of the left choroid plexus in the lateral ventricle. It occurred in an old man

affected with chronic *hydrocephalus*. Both *plexus* contained numerous arenaceous concretions, all of the same form as those in the pineal gland, and which have been figured by Valentin. The epithelial cells contained reddish-brown pigment-molecules. The shell-like growth itself consisted of a substance, splitting up at the borders into fibres, and in which round and oval, hyaline cartilage-cells might be discerned; in the more consistent parts of the deposit these cells had undergone a metamorphosis into finely toothed bone-corpuscles disposed at regular intervals.

The question now arises, as to how these ossified excrescences are developed? After what has been stated above, with respect to the papillary new-formations of connective tissue on the synovial membranes, and the formation of ossifying cartilage-cells in the hollow *sacculi*, it may perhaps be assumed with some probability that a *blastema* is deposited on the free surface of the arachnoid in a rounded form, which gradually becomes organized. The mode of the osseous formation may be explained in two ways: either cartilage-tissue is formed immediately, from which the bone is forthwith developed; or its formation is preceded by that of an independent, capsular wall, enclosing the *blastema*, and consisting of an apparently structureless membrane, or of fibre-cells arranged in close contiguity, and which are transformed into connective-tissue-bundles. Within this wall the cartilage- and osseous tissues are produced from the *blastema*.

Among the *fibrous membranes* the *periosteum* is chiefly the seat of very bulky new-formations of bone; and it is here especially that they assume all those forms which have been assigned by Lobstein to osteophytes in general, such as—the *diffuse* form, appearing as a thin layer incrusting the bone over a greater or less extent of surface, or as a fibro-reticular crust. The *concrete* form assumes the shape of warty granulations, pointed spicules, scale-like leaves, stalactites, styloid processes, stellate projections, and cauliflower-like excrescences. These terms, which might be considerably multiplied, will suffice to show the polymorphism of these growths. The various forms pass into one another, or may be combined, and, consequently, should not be regarded as distinct species. We shall here only give figures of some of them. In fig. 136 is

represented an osteophyte developed after amputation of the *femur*; *a*, corresponds with the sawn surface of the bone

Fig. 136.

which has been divided down the middle; *b*, the site of the amputation; *c c*, the osteophyte. On the side towards the place of amputation the latter presents smooth, warty, rounded elevations. On the sides of the bony deposit, numerous, larger and smaller, sinuous depressions may be noticed, leading sometimes to fissure-like cavities, sometimes furnished with several secondary excavations, which, again, are produced by projecting bony ridges. Superiorly, long, pointed spinous processes project from the hinder part of the osteophyte, occasionally enclosing infundibuliform hollows.

The medullary canal of the *femur*, near the site of amputation, was only incompletely obstructed for a distance of about an inch by a yellowish, friable, amorphous material, which was deposited on the wall of the medullary canal, and increased in thickness towards the lower part. In this substance some reticulated, fine osseous spicules might be noticed. Higher up, where the deposit of amorphous, crumbling substance did not reach, the entire thickness of the medullary canal was occupied by a delicate, arachnoid network of osseous *trabeculæ*, which, when examined more closely, were found to be constituted of dendritic filaments projecting freely into the medullary cavity. The bone-corpuscles, disposed along the axis of the filaments, were more or less hidden by the yellowish-brown, readily lacerable, intercorpuscular substance, though still perfectly recognizable.

In a second preparation, made by Dr. Zsigmondy, the obturation of the medullary canal, after amputation of the *femur*, had advanced to a slight extent; towards the site of the amputation the trabecular tissue was rather closer, and bony rays could be seen projecting into the *cancelli*, having a slender, elongated stem, and a clavate extremity, exactly like the club-shaped new-formations of connective tissue. In the more flattened, occasionally cribriform parts, a powerful lens brought into view minute, broad, and closely adherent nodules, analogous to the hemispherical and papillary new-formations of connective tissue projecting into the *areolæ*.

The osteophyte, which was situated on one surface of the *femur*, presented to the naked eye a perforated aspect; by means of the lens, the perforations were seen to be the oblique orifices of narrow channels communicating with each other, whose walls could be accurately traced only under a somewhat higher magnifying power. At their free border, the latter presented numerous, irregular, jagged prominences (fig. 137), and elsewhere, on the surface, slight elevations and depressions, in which were visible several secondary openings and ridge-like elevations. Larger, also oblique, narrow fissures could be seen at unequal distances apart, by which several systems of *lamellæ* were formed, and an appearance not unlike that of the spongy bones of the nose given to the osteophyte. These fissures, communicating with each other, are precisely analogous to those which are met with in various connective-tissue-growths. The *areolæ* of the newly formed bone had, in other places, a rounded shape, and, when of larger size, were subdivided into secondary or accessory *areolæ*, by bifurcating, osseous projections in the form of rays. It is, hence, evident that the *new-formed osseous tissue* presents the same type of construction—viz., the *areolar*, as connective tissue,

FIG. 137.

and also that analogous, ossified papillary growths spring up in the *areolæ*.

The formation of osteophytes of this kind, on the larger cylindrical bones, such as the *tibia* and *fibula*, may not unfrequently be observed, in the recent state, in persons suffering from what are termed varicose ulcers. In these places, the *periosteum* appears to be considerably thickened, and more firmly adherent than usual, its vessels, also, being enlarged; it forms a coating intimately united with the new-formed bone, and sends strong connective-tissue processes into the superjacent muscular substance, at the same time insinuating itself into all the depressions of the osteophyte. When the osseous spicules are traced in their continuity with the soft parts, the same thing precisely will be observed, as has been noticed above, as occurring in the osteophytes of the vitreous table of the skull, that is, a layer of minute, sometimes oval, sometimes fusiform cells will be perceived, which manifestly undergo a transformation into bone-corpuscles, and on that account might be regarded as cartilage-cells.

The osseous new-formation proceeding from the *periosteum* may, especially in the larger bones, increase to such an extent, that a considerable portion of the bone is surrounded by it in a sort of capsule, and becomes necrosed. This *secondary necrosis*, proceeding from the periphery, has been erroneously described by many surgeons as a central *necrosis*.

The new-formation of bone-substance is frequently *associated* with that of *pus*, and this is the case, not only in the compact, but also in the spongy parts of bones (in *caries*); and the abscesses, as has been before stated, may contribute to the formation of *sequestra* and *cloacæ*.

The *pathological process* may be thus described: the hypertrophy of the *periosteum* extends also to that of its vessels, which convey more nutriment, and thus is induced a locally exalted nutrition, and the production of new systems of bone-corpuscles; the latter, originating in the metamorphosis of cells resembling those of connective tissue, follow different directions, and it depends simply upon their mutual relations, what form is assumed by the osteophyte. The deposition of osseous substance may be conceived of as taking place in two ways, either a blastema (exudation) is afforded from the vessels of

the *periosteum*, in which new-cartilaginous and osseous tissue arises, which is not till afterwards, in the course of its growth, brought into union with the peripheral tissue of the bone, or the new layers are deposited immediately upon the old. That the new-formed osseous tissue enters into an organic connexion with the original bone, is obvious from the inosculation of the medullary canals on both sides; but the development of the former may take place independently, so rapidly and to such an extent, by a newly developed vascular system, that the old bone, together with its nutrient vessels, falls into a state of involution.

Of ossifications occurring in unusual situations, but few have come under our observation. The ossification of the tendons, formerly described by Miescher, was noticed on one occasion, by Professor Dumreicher, in the dead body. The tendon of the *biceps brachii* was transformed into a bony substance, commencing at its insertion into the tuberosity of the *radius*, the density of the osseous substance increasing upwards. The bone-corpuscles appeared alternately elongated, and many rayed, in other places, of the round or suboval form, with short prolongations from the sharp points. The medullary canals formed a delicate network, and expanded into considerable *cancelli*. The osseous rays, extending along the tendon, were jagged, and imbedded in the connective-tissue substance, which, here and there, exhibited oval cartilage-cells containing a granular *nucleus*. This ossification of the tendons has but little surprising in it, since we know, from Kölliker's researches, that in the stronger tendons, towards their insertions, oval cartilage-cells exist in considerable abundance. At the insertions into the bone of tendons containing cartilage-cells, that author has even seen, in some degree constantly, cartilage-cells in the most various transitional stages towards bone-cells, particularly those with thickened walls, and a more or less advanced deposition of calcareous particles; and besides these, he has noticed perfect bone-corpuscles, with pores and a more homogeneous wall, still lying free in the matrix of the cartilage.

Miescher has also observed genuine osseous tissue in healthy muscles in what are termed "exercise bones" (Exercirknochen); and Valentin describes the same thing in the osseous plates

met with in atrophied eyes. Ignaz Meyr noticed an irregular annular ossification in the site of the ciliary body in an eye in a state of atrophy, and in which the *cornea* was opaque, and the pupil closed. Rudolph Wagner found in the eye of a male subject a flat, discoid lens, as hard as stone; it was converted into true osseous substance, and contained medullary canals. (Virchow inquires whether, in this case, an ossification behind the *lens*, which so often occurs, combined with its total disappearance, might not have given rise to an error in the observation.)[1]

In an atrophied eye, which was flattened in front, and exhibited a stellate *cicatrix* in the *cornea*, we observed, together with a total absence of the *retina*, vitreous body, and *lens* (the globe being filled merely with a thin, yellowish-red fluid), on the inner side of the choroid coat, numerous, more or less extensive, isolated, grey, resistant, and firmly adherent aggregations, projecting, in the form of minute nodules scarcely visible to the naked eye, into the cavity of the bulb. These little nodules consisted of bone-substance, the corpuscles in which, had sometimes the embryonic form, and were large, oval, with a faintly jagged outline, whilst others exhibited longer projections, the corpuscles themselves being slenderer. In the same way, also, the intercorpuscular substance appeared, in many places, to be composed of thick fibres, decussating in various directions, and leaving everywhere minute vacuities between them, whilst, in other parts, the fibres composing this substance were already fused into a homogeneous, finely perforated mass. Contiguous to the ossified part, a tissue of cartilaginous consistence and yellowish colour, could be perceived, containing numerous, mostly oval, light coloured cells, imbedded in a fibrous *matrix*; the latter cells, however, could not be distinctly viewed except in a single layer. Towards the ciliary body, the thickness of the bony substance increased nearly to 0·44‴. Beneath, and close to the cartilaginous layers, granular, flattened, oval, elementary organs, aggregated into layers, were apparent, together with shreds of the *mem-*

[1] [In the 'Report of Proceedings of the Pathological Society,' for 1850–51, p. 183, a case is recorded by Mr. Canton, in which the crystalline lens was converted into a calcareous material, but here the change seems rather to have been cretification than ossification, and to have been limited to the capsule.—Ed.]

brana limitans (?). The *iris* was intimately united to the *cornea* by connective tissue, which, in this situation, was accumulated in the form of a soft-lacerable, embryonic substance, into which several blood-vessels could be traced. In the optic nerve, which was reduced to at least half its diameter, not a single nerve-tube could be discerned, nor, in fact, anything but dense connective tissue.

We noticed a very rare form of *ossification* in a *fibroid tumour* of the *uterus,* which was about the size and shape of a small hen's egg, presenting a tuberculated, botryoidal surface, and having, in all parts, the consistence of bone, beneath the membranous capsular envelope. When sawn across, in the dry state, it exhibited, towards its pointed end, a cavity about the size of a bean, smooth on the inside, and lined with a delicate membrane; and around this part the substance was manifestly more compact than elsewhere. More externally, as well as towards the lower end of the growth, soft cretaceous masses were insinuated between other portions, which, in the surface of a section, appeared denser and shining, and bounded by an irregularly lobate outline. *Laminæ,* sawn off and polished, presented a considerable diversity of structure, for whilst, in many places, the most distinct bone-corpuscles were apparent, in others they were wholly wanting. These corpuscles were grouped in concentric layers around *areolæ,* filled with opaque calcareous salts, removable by acids (fig. 138, *a*), were sometimes of an elongated shape, and furnished with numerous radiating and bifurcating *canaliculi,* and sometimes approached the round or polygonal form (*b*), in which case the rays were, generally, shorter. The differences in their size also were very remarkable, as were the irregular distances at which they stood apart.

Fig. 138.

Many of the groups formed by these corpuscles, contained perfectly opaque calcareous masses, soluble in acids. The separate systems of bone-canaliculi, interdigitated with each other, in a manner similar to, but not so regular as, that in which they are disposed, for instance, in the compact substance of the cylindrical bones. Of particular interest were those parts in which nothing could be distinguished but irregular, jagged, streaky masses of the most various dimensions (*e*); whilst in the intermediate substance, a regular bone-corpuscle could only, here and there, be perceived. These masses, however, should not be confounded with the opaque portions (*c*), which can be regarded only as larger and smaller *areolæ*, filled with pigment and calcareous salts, precisely analogous to the irregular deposits in the *pleura*, the cysts of the thyroid gland, and in the larger vessels. The interstitial substance appeared indistinctly striated. In the ossified spots, numerous ramifying medullary canals of considerable size could be perceived, but these were for the most part obstructed by opaque masses, whilst those in the merely cretified portions, did not appear to be so filled; some dark streaks might be due to shrunken blood-vessels.

The membranous capsule of the osseous structure, when softened by maceration, was seen to consist of a very dense tissue of decussating fibres; no trace of a cartilaginous layer was perceptible. In the same *uterus*, moreover, besides this ossified growth, fibroid tumours of the usual kind also existed.

The development of the osseous tissue in this case, took place only in parts, whilst in the intermediate portions, the growth had not advanced beyond the formation of deposits of calcareous salts in the *areolæ*, and areolar passages; the blood-vessels, as well as the other organic structures, being in a state of atrophy. But the medullary canals in the fully formed bone-substance, and its corpuscles, were also involved in the cretification.

If, with Rokitansky, we amplify the idea of an osteoid growth, it may be made to include such a new-formation as the present, but, at the same time, being non-malignant, it must be distinguished from the apparently similar growths of a different nature, described by Joh. Müller (which belong to cancer).

IX. NEW-FORMATIONS OF THE DENTAL TISSUES.

Three kinds of hard tissue, as is well known, exist in teeth —the *dentin*—*enamel*—and *cementum*, and the new-formation of these tissues may be studied in the same order.

The true nature of the bodies termed by Linderer "juice-cells" (Saftzellen), and previously described by R. Owen as "dentine-cells," was first correctly appreciated by J. Czermák, by whom they are denominated "globular masses;" whilst Kölliker terms them "dentin-globules."

Their essential nature and physiological import are, as yet, by no means established; this much only having been ascertained by pathological research, that precisely isomorphous, globular masses also occur in cretified exudations (*vid.* fig. 51, *c*). They appear to us to be spherical deposits of a protein-substance impregnated with calcareous salts, into which the dentinal canals, furnished with independent walls, are continued. They obtain a certain pathological importance when in excessive number, and of considerable volume, and when formed in parts of the dentin where they do not occur in the normal condition. Like the globular masses, the interglobular spaces also increase in dimensions, and contain sometimes a transparent substance, though not unfrequently an abundance of calcareous salts, soluble in acids, or of blackish-brown pigment masses. In fig. 139 the latter may be seen constituting thick layers, interposed between the globular masses. In the instance from which the illustration was taken, that of an incisor tooth in a youth of sixteen, these layers, arising from the interstitial substance of the *cementum* and dentin, could be traced across the entire thickness of the latter, in obliquely ascending lines. It is well known that, in teeth exhibiting this structural

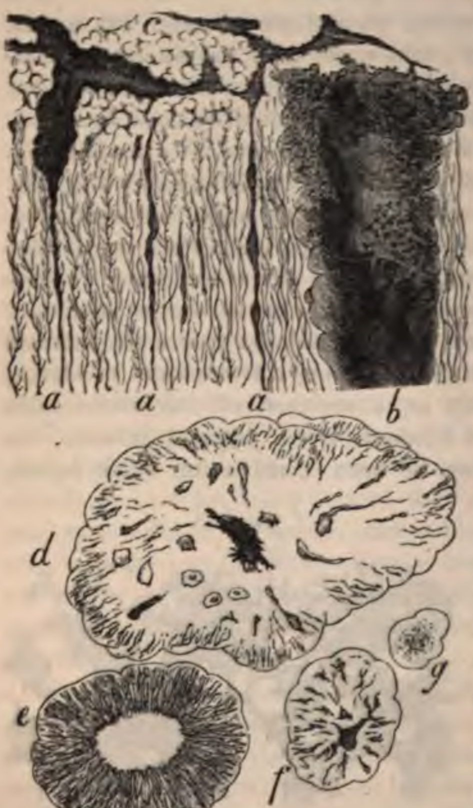
Fig. 139.

anomaly, slight annular ridges are visible, even by the naked eye, surrounding the root, which correspond to the origins of the patches or tracts of globular masses and wide, opaque, interglobular spaces.

The lamellar disposition of these masses towards the crown of the tooth is also, without doubt, connected with the lamellar formation of the dentin in *alveoli* (depressions), the existence of which has been shown by Kölliker's researches.

The globular masses sometimes assume a dark colour; so deep, in fact, that their boundary is only rendered apparent by a light seam. They insinuate themselves, in the form of apparent canaliculi, proceeding from the outer or inner surface of the dentin, and have been variously misinterpreted. Thus Linderer speaks of the formation of new canals in the dentin; meaning, probably, thereby, only dark globular and interglobular masses. In fig. 140 is shown a vertical section of the root of a dead bicuspid tooth; at *c*, the small globular masses rest upon the dentin; the proper *cementum*, containing bone-corpuscles, being omitted in the figure. Close to *c*, will be noticed irregular, dark spaces, continuous with *striæ* (*a a a*), of various forms and which penetrate deeply into the dentin. These vacuities, which often present varicose dilatations, are very fre-

Fig. 140.



quently seen in the dentin of old teeth presenting no appearance of *necrosis* or *caries;* and when shorter, or when truncated at each end in the preparation of a section, have been described as bone-corpuscles.

J. Czermák has shown the erroneousness of this notion, and expressly states that he has never seen a genuine bone-corpuscle in the dentin. A mistake of this kind, moreover, would be the more readily made, since these dark spaces have irregular prolongations, like the bone-corpuscles. The irregularity of their conformation, therefore, would afford the only criterion of their true nature. Occasionally, also, the direct communication of a fissure-like cavity, with a dentinal tubule, may be readily traced; or it might, even, almost be said, that the latter was dilated and varicose.

The dark mass (*b*, fig. 140), in this instance, extends transversely through the entire thickness of the dentin, becoming slenderer towards one end, and more transparent.

Now, how does it happen that the globular masses advance into the substance of the dentin; whence do they get their dark colour; and what is their pathological import? It has been shown that the dentinal canals represent a connected system of tubes, furnished with independent walls, and connected by anastomosing branches. This system, on its peripheral and central aspects, is covered with a layer of hyaline globular masses, separated by interstices. The dentinal tubules convey a fluid subservient at the same time to the nutrition of the dentin; but the globular masses have also some relation to the nutrition of the dentin, with which, it must be confessed, we are not accurately acquainted. On the one hand, these masses are secreted on the inner surface of the dentin by the vessels of the pulp; but, on the peripheral aspect, the nutritive juice which coagulates into the globular form, can only be afforded by the vessels of the alveolar periosteum, and this juice must penetrate through the *cementum.* Under particular circumstances, the plasma accumulates, in many places, in considerable quantity, and causes, both from without and from within, a fusion of the corresponding part of the dentin, or it may even penetrate entirely through it, especially towards the point of the fang, in the form of an apparent

canal; and undergo, after its coagulation, retrograde metamorphoses.[1]

If now, as has been stated above, the globular masses are of the nature of protein-bodies, what are the conditions displayed in their further organic development? In the dentin, close to the *cementum* at the point of the fang of an incisor tooth, whose enamel was necrosed, we noticed the mass represented at *d*, fig. 140; its periphery was sharply defined by a sinuous outline, from which radial striæ might be seen running for a short distance, forming irregular furrows, diminishing in width towards the centre. In the latter situation, an opaque mass, with unequal, jagged prolongations, was present, but which did not possess the type of a normal bone-corpuscle. The rounded, angular bodies, with a long process, in the mass *d*, were worthy of notice; some of them contained a corpuscle not unlike a *nucleus*.

In the same tooth, at a short distance from the above-described mass, another of similar kind was met with (*e*), in which the radial striation was still more distinct, and the central cavity filled with an amorphous, brownish-yellow substance.

Smaller, dark, irregularly toothed masses might also be observed (as at *f*), containing several streak-like vacuities, around which, bodies, either perfectly transparent, or composed merely of a punctiform substance (*g*), were found imbedded in the dentin. With respect to which, it should be remarked, that it often seems as if these masses, which are sometimes light coloured, sometimes very dark with pigment, lie free in the the substance of the dentin; but the circumstance that, in perpendicular sections of teeth, they are seen passing through it obliquely, outwards or inwards, and, moreover, the direct evidence of their radiation from the peripheral or central surface of the dentin, render still more difficult the,

[1] In several instances, we have noticed, towards the point of the fang, in incisor, bicuspid, and molar teeth, a perforation through the thick *cementum* having the appearance of a straight, sharply defined, light or dark streak, from which occasionally, lateral branches arose. These streaks in the *cementum* consequently differ from those situated in the dentin, in the want of the hemispherical projecting masses. With Kölliker we regard them as medullary canals, and would at the same time remark, that they should not be confounded with the irregular interglobular spaces.

a priori, improbable, supposition, that these masses may arise independently in the dentin.

The globular masses are sometimes developed in a more bulky form on the inner surface of the dentin, and undergo organic metamorphoses of the same kind as those to which the dentin and osseous tissues themselves are subject. These solid new-formations were known even to Prochaska, and have lately been more accurately described by F. Ulrich, who found them in the substance of the pulp, or on its surface, and mostly on the aspect directed towards the masticatory edge or surface of the tooth; they vary in dimensions, from a size just perceptible, to a bulk nearly or completely filling the cavity of the tooth. He distinguishes two kinds of substance — one resembling bone, *osteoid*, and one like dentin, *dentinoid*—together with a combination of the two. From the results of our own investigations, we think it more suitable to employ for this new-formation the term *osteo-dentin*, selected by Owen (for the dental substance of many Fishes and some *Edentata*), its structure being really intermediate between that of bone and of dentin. We shall illustrate the account of it by some instances. An incisor tooth (fig. 141, A) had suffered a considerable loss of substance at the neck (*d*). In places towards the upper part of the fang, where the dentin appeared spotted, several dark vacuities extended from the *cementum* (*a*) deep into the substance of the dentin (*b*). This tissue, as well as the enamel (*c*), was removed in the site of the excavation (*d*), only a remnant of the dentin forming its floor. At this part the usual metamorphoses of necrosed dentin could be readily observed; the most external portion was of a dirty-yellow, or yellowish-red colour, and might, inadvertently, have been taken for enamel. The colour resided in the intertubular substance, and the tubules became gradually unrecognizable. In the deeper layers, next to the carious spot, the dentin presented a chalky aspect, and had lost its proper transparency, the corresponding tubules, here and there, containing opaque granular masses. But what was of most interest, was the substance deposited on the upper surface of the dentin (*e*), and which exhibited other important characters; it was more transparent, the regular disposition of the tubules was lost, and amorphous, jagged cavities filled with an opaque substance

were apparent, communicating with each other by zigzag, irregularly bifurcating tubules, immediately continuous with those of the dentin. The above-mentioned dark vacuities frequently exist in the *osteo-dentin*, and should not be confounded with bone-corpuscles. Besides this, globular masses, in the form of elliptical, hyaline bodies, are invariably present in the younger states of this new-formation.

Fig. 141.

In a molar tooth, we observed a mass of *osteo-dentin*, highly developed, and of unusual size (fig. 141, B); it was seated in the dilated pulp-cavity of the fang, of an oval form (d), and about 2·21‴ in length, presenting a peripheral dentin-substance surrounding the central, osseous part, in the form of a ring. In the latter might be seen straight, anastomosing cavities, the thicker of which were as much as 0·047‴ in diameter, and filled with a dark, brownish-yellow substance; whilst the smaller, which were transparent, were scarcely 0·0088‴ in size. Between these cavities, which are analogous to medullary canals, were lodged bone-corpuscles, characterized by their diversity of shape; for whilst many possessed all the characters of the corpuscles of the *cementum*—that is, were furnished with the same fine, reticulating, and numerous *canaliculi*—others, still distinctly recognizable as bone-corpuscles, having a diameter of 0·046‴, exhibited merely an indented outline. Many were widely removed from common bone-corpuscles, partly by their enormous size (0·0177‴ more), partly on account of their irregularly bulging or straight form, though they still retained the numerous radiating *canaliculi*. Towards the periphery of the new-formed dentin, irregular, larger or smaller, inter-

globular spaces filled with an opaque material were visible, presenting in many places the usual type of the similar spaces situated between the *cementum* and dentin, with the minute, elliptical, globular masses imbedded in them.

The tubules of the *osteo-dentin* (B, *d*) following the direction shown in the shading of the figure, appeared to be continuous, in many places, with those of the contiguous original dentin, and, at the point nearest to the apex of the fang, decussated with the latter at a right angle. The plane of radiation of the tubules of the *osteo-dentin* was at the periphery (that is to say, the tubules ran and ramified towards the central, osseous substance, presenting, in their course, well-marked, wavy curves; their arrangement and mode of ramification, otherwise, resembling those of the tubules of the perfect dentin. From the central substance of the *osteo-dentin*, several dark, globular masses insinuated themselves to some depth into the newly formed dentin. In one place, an opaque mass, bounded by a well-defined, light-coloured border, about 0·0177‴ in breadth, and surrounded by globular masses, extended almost through the dentin; and from this, short, radiating, delicate *canaliculi* were given off, which decussated with the larger tubules of the newly formed dentin. Where the tubules of the latter were not continuous with those of the original dentin, they were parted by the interposition of a transparent, globular substance; and a similar substance also existed on the free surface of the *osteo-dentin*, where it projected into the pulp-cavity. No structural anomaly could be discerned in the *cementum* (fig. 141, B, *a*) nor in the dentin (*b*); the enamel was necrosed over a small space.

A precisely analogous instance was presented in a molar tooth. The *osteo-dentin*, in a transverse section, also exhibited an oval form, and a longitudinal diameter of 0·44‴; and, like the former, it was seated on the wall of the pulp-cavity, towards the apex of the fang. The interior substance was situated excentrically, and extended in the form of an irregular, much indented, elongated mass, in the longitudinal axis of the new-formation. The substance itself appeared to consist of a hyaline, globular material, from whose periphery short canals, here and there, radiated. The new-formed systems of tubules, as in the former case, presented a radial arrangement;

and their course was characterised by numerous zigzag curves, as well as by their giving off very many bifurcating branches, in such numbers, in fact, that the tubules rapidly diminished in size; it appeared, also, as if they were directly continuous with those of the original dentin. The concentric lamination of the new-formation, indicated by faint concentric *striæ*, was very evident towards the surface.

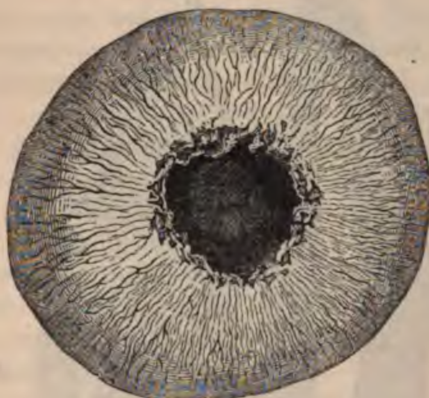
In the same tooth, several smaller masses of *osteo-dentin* were found attached to the dentin, which was otherwise in perfectly normal condition. These growths varied in shape according as two or several were in contact with each other.

A well-marked instance of the occurrence of numerous masses of *osteo-dentin*, closely attached to the inner surface of the dentin, was afforded in the fangs of a molar tooth, of which the enamel was carious. The central substance of the new-formations resembled, to some extent, an agglomeration of opaque, variously shaped masses, which in some cases were directly conjoined by elongated processes; whilst others diminishing in size as they approached the new-formed dentinal substance, became elongated like the dentinal tubules, gave off lateral branches, and were directly continuous with those running inwards from the peripheral portion of the *osteo-dentin*. In other instances, the opaque masses of the central substance were assembled so as to form tubes, and had coalesced. The tubules of the *osteo-dentin* presenting the characters above assigned to them, opened, not unfrequently, into fissure-like spaces, and in several parts were manifestly connected with the tubules of the original dentin, so much so, in fact, that it might truly be said that the latter were continued into the new-formed dentinal substance. Owing to the mutual apposition of so many masses of *osteo-dentin*, contiguous systems of dentinal tubules were presented, some encircling the rounded new-formations, others passing through them.

Simpler forms of *osteo-dentin* occurred in an extracted incisor tooth belonging to an individual, sixteen years of age, which otherwise showed no trace of disease externally. The new-growth, which presented the form of several, suboval, sometimes isolated, sometimes coalesced masses, was lodged in the terminal portion of the pulp cavity; its longitudinal diameter was 0·17‴. The *osteodentin*, represented in fig. 142,

contained a dark-grey, amorphous, central substance, with some, rather lighter spots, surrounded by brownish-red, irregular, indented masses, disposed in several successive layers,

FIG. 142.



and wanting the characters of perfect bone-corpuscles. We regard these as interglobular masses [spaces], which, as on the outer periphery of the normal dentin, were directly continuous, with one or more dentinal tubules. The latter, in the new-formation in question, exhibited a radiate disposition, as in the case before described; and the lamination of the dentinal substance was also evidenced by concentric streaks.

The other osteo-dentinal masses in the extracted *incisor* (fig. 143, *A, c c*) afforded, in all essential particulars, similar characters. We would, here, merely add that, in the *cementum* (*A, a*), several, abnormal globular-masses were imbedded, and that the dark, obliquely ascending streaks in the dentin (*A, b*) represent the abundant interglobular substance (compare fig. 139). The enamel (*A, d*) was characterised by its dark striation, an indented contour line (in the section), and its systems of enamel-prisms, which decussated with each other under other angles than in the normal condition.

In another molar tooth, especial interest was excited by what, to all appearance, seemed a *newly formed mass of enamel*, lodged in the dentin. On the neck of the tooth, above the transverse furrow, an excavation existed, about the size of a pin's head. The tooth was divided into a right and left half;

one of these portions, when polished (fig. 143, *B*), exhibited, at *c*, a new-formed growth, the upper segment of which consisted

FIG. 143.

of a circumscribed globular mass, with dark, interglobular spaces; towards the centre it presented a dirty brownish-yellow colour, and, in that situation, no determinate structure could be detected. In the lower segment, on the other hand, it was impossible to doubt that new enamel had been formed; the position of the prisms, as viewed in longitudinal and transverse sections, their uniformity in size, and brownish-yellow tint, affording sufficient evidence of the fact. The interspace between the imbedded mass of enamel, and the upper border of the old enamel, amounted to nearly 0·44‴, and was occupied by normal dentin. Lastly, the lower segment presented an oblique excavation. The other half of the tooth exhibited, at the corresponding part, a hole about the size of a pin's head. It was evident, therefore, that the loss of substance in the dentin had been concealed by the newly-formed growth. A

similar appearance may be observed in fig. 141, where the loss of substance at *d* is lined on the inside by the *osteo-dentin* at *e*.

The formation of *new layers of cementum* takes place towards the end of the fang, either around its whole circumference, or in one part only; the former is the case, as is well known, in old teeth, and the formation not unfrequently proceeds to the development of medullary *canaliculi*, according to Kölliker's observations, more particularly with respect to the molar teeth. These canals may also be observed in the *cementum* of younger teeth, mostly in connexion with what is termed "dry caries;" we have noticed a clear canal, 0·0177‴ in diameter, ascending obliquely from the point of the fang towards the dentin, in an incisor tooth affected with slight, partial necrosis of the enamel and dentin. The layer of *cementum* was 0·36‴ thick. In a molar tooth, in a state of *hyperostosis*, we have seen *canaliculi*, sometimes branched, sometimes dilated into *cancelli*, which should not be confounded with the irregular, polymorphous spaces first described by Czermák, and which do not appear to Kölliker to be anything more than hollows produced by absorption. In our opinion, they might also arise from the involution of globular masses, together with that of the interglobular spaces. On the other hand, we have often observed hemispherical, sinuous masses projecting from the globular substance interposed between the dentin and *cementum*, entering the latter, and are satisfied that even new-formations of bone-corpuscles may take place, within a globular mass of this kind, precisely in the same way as they are seen to be formed on the *cementum* of the Horse's tooth.

In the second case, where the new-formation of cement-layers takes place only on a part of the root, a nodulated elevation is produced. A growth of this kind was situated towards the point of one of the fangs of a molar tooth affected with *caries*. On the dentin, which elsewhere exhibited no abnormal condition (fig. 144, *a*), rested numerous layers of globular masses, with large, dark interstices, looking sometimes like chinks or fissures, succeeded, externally, by many rayed, genuine bone-corpuscles in considerable number. In some places, which were extremely opaque, they seemed, as it were, to be fused together, or to be rendered less distinct by a

brownish, intercorpuscular substance; and in the same spots, opaque masses were collected in irregular cavities. Between the bone-corpuscles, fissure-like, irregular spaces could be seen crossing the osseous *lamellæ*, and extending from above downwards, in an oblique direction. In many places, the latter not unfrequently exhibited undulating curves; they were more distinct where the bone-corpuscles were rarer, and terminated occasionally at an obtuse angle (as at *b*). In the blackish-brown portions (as at *c*), only an occasional glimpse could be obtained of bone-corpuscles.

FIG. 144.

The nutriment of the solid constituents of the teeth is supplied on the one side by the vessels of the pulp, and on the other by those of the alveolar *periosteum;* and it is by the latter, although in the human subject they are not normally distributed in the *cementum*, that the nutrition of that tissue is in reality carried on. Now if, on either side, owing to an increased transudation, more nutriment be afforded, either the substance of the *cementum* becomes blended with that of the *alveolus*, or, should this be denied, the osseous substance of the latter, the position of the tooth remaining the same, must undergo a partial fusion, in order to make room for the hypertrophied *cementum*.

The new-formation of bone may also originate in the *alveolus*, and be confined to it, to such an extent, in fact, that, by degrees, the cavity is nearly filled with bone; as, for instance, after the loss of the teeth in old age.

A remarkable new-formation of tooth-substance came under our observation in a body removed by Dr. Jarisch, and which, after repeated and careful examination, we cannot but regard as a malformed tooth. It was situated in the region of the right wisdom-tooth, and, after the considerable swelling of the

surrounding parts had subsided, was removed without much difficulty by the forceps. After previous cleansing of the place, the body was at once perceived, imbedded in the substance of the wisdom-tooth.

When extracted, it presented a rounded figure, flattened beneath. Its different diameters were respectively as follows: from the centre of the base to the corresponding highest point=0·075″ (height); from before to behind=0·082″ (length); from side to side=0·058″ (width).

The surface was nodular; on the attached or basal aspect (fig. 145, *b*) could be seen an excavated depression, surrounded by a projecting ridge (*a a*), the circumference of which corresponded with the borders of the crown of the wisdom-tooth. Two kinds of substance could be perceived on the surface even by the naked eye; the one towards the basal portion was whiter, smoother, and with a pearly lustre, especially on the circular ridge (*a a*), whilst, on the surface of the other, larger and smaller holes could be perceived (as on the upper surface, *c c*, or on the side, *d*), which, when traced in a section, were found to correspond with a number of fine white *striæ*. The consistence was compact, and the sound afforded, when struck with an iron blade, was more ringing and poorer, that is, attended with less resonance, than is the case with bone. The tone corresponded precisely with that afforded by a tooth when struck in a similar manner.

FIG. 145.

The examination of the section, which had been made perpendicularly to the basal surface, at once showed the existence of radiating canals, 0·0088—0·088‴ in diameter, running from the periphery towards the base, and filled with a material resembling fat-globules. No blood-vessels could be observed in the canals, nor did they give off any branches. These vacuities, which looked like medullary canals in a state of involution, evidently opened on the surface of the structure at the orifices which were discernible by the naked eye.

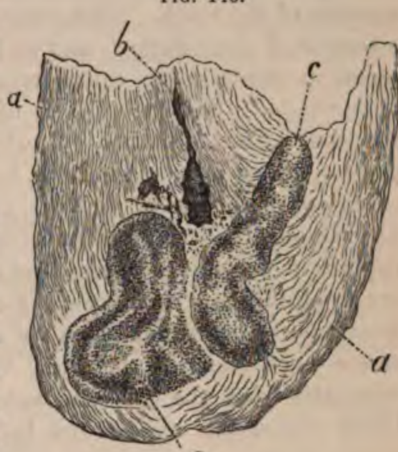
Closer investigation proved that the main constituent of the growth was *dentin-substance*, and that the tubules differed from those of common human *dentin*, only in the circumstance that they were larger at their origin, their many curves more strongly marked, and the dichotomous branchings more numerous, so much so, in fact, as to cause a rapid diminution in their diameter. The thickness of the dentin was proportionate to the bulk of the different, adventitious substances, according to which, also, the course of the dentinal tubules was directed. These tubules originated around the surface of the medullary canals, curving, not unfrequently, at a right angle, and uniting, occasionally, from both sides into a single bundle; entire *fasciculi*, also, of dentinal tubules might be noticed arising from the cæcal ends of the medullary canals, whence they spread out in a fan-like manner. Between the systems formed by these tubules, groups of larger or smaller hyaline globules (globular masses—dentin-globules) were often interposed, and, occasionally, opaque, tubular, finely indented spaces, with an irregular outline, might be perceived between them, into which, and especially into those of smaller size, dentinal tubules could be traced. The terminal branches of the latter were in connexion, on the one hand with the cuneiform masses of enamel which penetrated into the substance in all parts, and on the other with the interglobular spaces and bone-corpuscles.

The *enamel* was thickest on the above-mentioned circular ridge at the base of the production, where its thickness amounted to 0·088—0·11‴. The colour and disposition, generally, were those proper to the enamel. Between the dentin and enamel, in the basal portion, a hyaline, structureless layer could be distinctly noticed, including arched loops of the dentinal tubules. The dichotomous ramifications of the latter, close to the enamel, were too closely crowded to represent regular *fasciculi*. The layers of enamel extended to a considerable depth in the upper half of the malformed tooth; they ramified in various directions, projecting into the dentin like sharply defined, papillary structures, surrounded by clear concentric layers, and by the dentinal tubules running towards them. The thickness of these plates of enamel was about 0·017—0·22‴; their colour, in many places, was a deep brownish-yellow, such as is not unfrequently seen in human

teeth when the enamel contains an abundant deposit of pigment; their texture could not everywhere be made out with equal facility, since in many places nothing was apparent beyond a brownish-yellow substance, presenting no texture whatever, whilst, in others, the enamel-prisms were clearly displayed, divided either obliquely or transversely.

A section in the long axis of the production exhibited systems of dentinal tubules, running in various directions (fig. 146, *a a*), and ending with their terminal branches, partly in the opaque globular masses surrounding the cavity (*b*), partly going towards the imbedded mass of enamel (*c c*).

Fig. 146.



True osseous substance occurred in very small quantity, whilst larger and smaller opaque, irregular, jagged, occasionally voluminous spaces, existed, which have already been, several times, noticed as of pathological formation; and, in normal teeth, have been described by Czermák as interglobular spaces.

The formation of this tooth, admits of no other interpretation, than that it was a *vitium primæ conformationis*, consisting, as it were, in the development of numerous papillary protrusions, on what is termed by Kölliker, the *organon adamantinæ*, which were adapted to similar protrusions of the dental pulp. But the development of fangs had not been reached in these papillary new-formations.

Lastly, in inquiring the relation in which the new-formations, and particularly that of osteo-dentin, stand with respect to *caries* of the teeth—we must first understand what is meant by that term, which has long been shown, by many observers, and more lately, again by Klenke, to be inappropriate. If the notion of *caries*, as applied to the bones, be restricted to an exudative process, always associated with *necrosis*, it does not apply to the affection described by dentists

as *caries sicca*, which must be regarded as a simple decomposition of the organic matter, as a kind of decay, or mouldering away, caused in particular localities in the tooth and in its parts, as Ficinus has clearly shown, by special external conditions, and advancing from without to within (*vid.* p. 161). Consequently, with this restricted meaning of the term, there would simply be a *caries* produced by the blood-vessels of the pulp, and one connected with those of the alveolar periosteum, which would necessarily be accompanied with a partial or complete necrosis of the tooth. This *caries* is, perhaps, in most cases, a *sequela* of the "decay," and so far as our experience extends, seems to stand in no causal relation with the formation of *osteo-dentin*. But the reverse of this proposition cannot be asserted. The formation of *osteo-dentin* is an independent process, which appears, perhaps, to be induced by the inward extension of the decay (fig. 141, *e*), but which may also be set up without that concomitant (fig. 142). But an abundant deposition of globular masses, and the formation of *osteo-dentin*, are so often found accompanying each other, that we have no hesitation in describing them as being intimately allied processes—not meaning, however, by this, that the *osteo-dentin* originates from the globular substance. That substance, as before remarked, appears to be an organic *matrix*, out of which, in particular situations, as on the surface of the pulp, and, perhaps, also within it, the growth of the new-formation is carried on.[1]

[1] [A very good account of the "globular masses" of dentin, will be found in the paper, by Czermák, referred to in the text, and which is contained in Siebold and Kölliker's 'Zeitschrift f. Wiss. Zool.,' vol. ii, p. 295 (1850). A *resumé* of his observations, so far as they refer to this particular subject, is also given in the 'Quart. Journal of Microscopical Science,' vol. i, p. 253 (1853), in a memoir by S. J. A. Salter, M.B., 'On certain Appearances occurring in Dentine, dependent on its mode of Calcification;' one object of which, is stated by the author, to be the giving of a summary and confirmation of Czermák's paper, in reference to certain points in the anatomy of dentine, and partly to add some further observations of his own.

The points chiefly contained in Mr. Salter's paper, concern the peculiar markings on the dentin, known as "contour lines" or "markings," and their appendages, the irregular patches of smaller interspaces which limit the outer extremities of those lines. As reference can readily be made to Mr. Salter's paper, which is illustrated by figures, it is needless, here, to say more on the subject, than simply to observe that Czermák's supposition with respect to the nature of the globular masses

X. CANCER.

What should be comprehended under the term *cancer*, is at present by no means established; this much only can be stated with certainty, that it is a new-formation, approaching *tubercle* on the one side, and on the other, allied to the embryonic and dendritic papillary new-formations of connective-tissue, and which may be associated with secondary formations of blood-vessels, cartilage, bone, and fat-cells; and is subject to a spontaneous (independent of external conditions) involution.

The forms under which cancer presents itself, are, as is well known, extremely multifarious; and an attempt has been made to classify these various forms, partly from their outward habit, partly from their more minute structure. But it is now understood, that such a classification is not, *de facto*, possible, since the forms pass into one another, and a combination of divers forms may exist in one and the same tumour. We recognize, therefore, but *one* cancer, whose multifariousness in external aspect, depends simply upon the stage of organization

and interglobular spaces, appears satisfactorily to answer all the conditions under which they exist. He suggests that the organic material of dentin is, during the calcifying process, impregnated with earthy salts in globular forms, and that by a deeper degree of calcific impregnation the whole tissue is imbued with the hardening element, and the globules become fused together. Such a doctrine, Mr. Salter says, "is capable of explaining all the circumstances of the case; and we have only to imagine an arrest of calcification at the globular stage over the surface of the pulp, as it exists at any one time, to explain all the phenomena of the contour markings."

This view of the nature of the globular masses receives a curious confirmation in a case related by Dr. Hyde Salter, in the fifth volume of the 'Transactions of the Pathological Society of London' (1854), p. 35, and pl. ii, of an ossific mass deposited in the *pleura*. The structure of this growth, when examined microscopically, presented a striking resemblance to the globular dentin masses and interglobular spaces, and what is more remarkable still, in many parts of it "groups of tubules exactly resembling dentine tubes were seen. They were about the diameter of ordinary dentine tubes running with a wavy parallelism, having traces of both primary and secondary curves, and showing in some parts a disposition to branch." Dr. Hyde Salter, also notices the microscopical appearances in a section of the bony matter of an ossified aorta, in which the structure was very similar.

The development of true bone in the pulp cavity, connected with the existence of what he terms "erratic vascular canals in teeth," is recorded by Mr. J. Salter (Ib., p. 115, pl. iv).—Ed.]

which the growth attains to, and the direction in which that organization proceeds.

J. Vogel has expressly declared, that there are merely *varieties* of cancer, which can be characterised under the terms, at one time, usually employed, and that the fine distinction, and definition of *species*, from unessential characters, leads to an endless multitude of names.

Regarding the subject purely in a histological point of view, we shall adhere closely to the morphological, elementary constituents, commencing with the *cells*. Their diversity of form depends upon: (*a*) the relative proportions of the three dimensions—length, breadth, and thickness; thus we have round, flat, and elongated cells, with every possible intermediate form; (*b*) the number of processes given off from the body of the cell, whether they are single, double, or multiple, and their different points of insertion, various length, thickness, and mode of division; (*c*) upon the *cell-contents* being more or less transparent, and consisting of either minute-molecules, fat, or pigment-granules; (*d*) upon the relation of the *nucleus* to the circumference of the cell, and the number, whatever it may be, of the *nuclei*; (*e*) upon the relations of the *nucleolus* to the *nucleus*.

A specific character has often been ascribed to the cells existing in *cancer* (Hannover, Lebert, Robin). Their excessive size, their breadth, the voluminous *nucleus*, the large prominent *nucleolus*, &c., are stated to afford positive characters; so much so, in fact, that Lebert says, that even an inexperienced observer will be enabled to recognize them. But we are entirely in accord with Virchow, who denies the specificality of cancer-cells. For comparative study, we should recommend the transitional *epithelium* on the ocular *conjunctiva*, the epithelial cells in the pelvis of the kidney, the occasionally enlarged epithelial cells of the *tubuli uriniferi* in Bright's disease, many kinds of ganglion-cells, the newly formed cells in the gelatiniform uterine mucus, in many gelatinous exudations, chronic ulcers, soft uterine polypus, in the *epidermis* of condylomata, warts, &c. Unprejudiced observation will then satisfy any one, that he would, but too often, be the victim of delusion, in laying too great a stress upon the value of the supposed characteristics of the so-termed "cancer-cells."

In the first place, our full attention is demanded to the *history* of the *evolution and involution* (vital course) of the embryonic-cells of *cancer;* with respect to which, some highly important circumstances must be regarded; these are: 1. The inordinate nutrition of the cell, in consequence of which, its volume (in general ranging between 0·004 and 0·04‴) may become very considerable; and the increase not unfrequently extends to the *nucleus* and *nucleolus*. This excess of nutriment, however, usually induces, on the one hand, a want of symmetry in the outline of the cell, so that its shape is distorted; and on the other, may be limited to an enormous growth of the *nucleus* and *nucleolus*, or to the extension of the cell-body or process in one direction—especially in width. 2. The excessive propagation of the cells is evidenced by a remarkable multiplication of the *nucleus*, so that often two *nuclei*, and not unfrequently 3—8 are met with in one cell. 3. The progressive formation of the cell is arrested at a certain stage, that is, round, elliptical, obtuse-angled, uni- or multipolar cells are chiefly noticed; the bodies of the latter, and especially of the fusiform-cells remaining proportionately broad. 4. The formation of a *nucleus* is not reached at all, in many cells; they consist simply of a membrane, and transparent molecular contents—as is especially evident in gelatiniform *cancer*. 5. Not only may the formation of *nuclei*, however, be achieved, but their spontaneous division, each subdivision being surrounded with a portion of contents, may take place, in which case, however, not a trace of an investing membrane can be perceived. 6. The nutriment afforded to the cells undergoes various anomalous changes, manifested in the alterations which take place in the cell-contents; these are gradually seen to include an increased amount of fat-globules, by which the cell is transformed into a granular-cell, and this, by the subsequent fusion of the cell-membrane, and of the *nucleus*, is finally metamorphosed into an aggregation of fat-globules or a granule-mass. This fatty metamorphosis of the cell-contents, which has been accurately investigated by Virchow, may be attended with a brownish-yellow, or reddish-brown hue in the fatty granules, from the imbibition of colouring matter. The molecular, transparent contents of the cells, in the pigmented metamorphosis, present larger or

smaller, isolated or aggregated pigment-granules, which appear to coalesce into blackish-brown masses, a change, accompanied in many places in a cancerous growth, with an evident collapse of the cells. A serous degeneration of the cell-contents, is manifested by an enlargement and proneness to rupture of the membrane, and by a greater distance between, or a rarefaction of the molecules, associated with which, a vesicular distension of the *nucleus* may frequently be perceived. 7. The rapid multiplication of the cells takes place in a curved line. The embryonic cells arrange themselves in chains, upon which are formed lateral branches and twigs, whence we ultimately see produced an arborescent system of embryonic cell-forms, whose contents are usually in a state retrograde metamorphosis. Their line of direction, as is particularly evident from the researches made on the subject of gelatiniform *cancer*, sometimes approaches the circular, or spiral, and in this way, cavities or fissures are produced, filled with a hyaline intercellular fluid (cancerous *blastema*, or *serum*). In which case, the wide interspaces between the separate groups of cells become incompletely filled with a trabecular frame-work, developed out of the fusiform-cells.

Virchow has observed that the *cancer-serum* is comparatively rather abundant, and that this circumstance may be held to explain the ready separability of the cells. It may suffer the same retrograde metamorphoses as the cell-contents undergo, losing a large part of its watery element, in consequence of which the protein and organizable compounds are precipitated. This involution of the *serum* necessarily induces a decay of the cells, and in these atrophied parts of the cancerous growth, we find nothing but traces of connective-tissue fibres, and disseminated among them numerous fat-globules, unaltered by acids or alkalies, free pigment, amorphous, calcareous particles, and plates of *cholesterin*.

In all fully formed cancerous growths there is another system of cells, whose development is continued by spontaneous division; these are the *fusiform* or *fibre-cells*. It is still a question whether these elementary organs stand in any genetic connexion with the rounded forms. We think, with Virchow, that they are developed in another direction, that is to say, into connective-tissue-bundles, whilst the other kind of cells remain in an embryonic stage, or, becoming atrophied, are

no longer capable of being transformed into connective-tissue-bundles. We have already indicated, in the General Part, (p. 77), that the fibre-cell is capable of spontaneous division, and of being multiplied in a spiral; consequently, the hollowness of the connective-tissue-*trabeculæ*, the continued development of entire chains of fibre-cells, the giving off of lateral branches and twigs, may all be explained in this way. This arborescent, branching system of fibre-cells with oblong *nuclei*, or of bundles of connective-tissue-fibres derived from them, is termed the *cancer-framework* or *stroma*. Its texture is essentially areolar. From the *trabeculæ* of this stroma, arise, in many places, (especially at the points where a branch is given off,) *papillary structures*, growing by the apposition of a molecular substance, which becomes organized into rapidly multiplying cells, belonging either to the oblong or the round form, and continues to grow into the *areolæ* and areolar passages of the *stroma*.

With respect to what has already been stated on the process of development followed in the papillary new-formations (p. 78), it remains to be added, that, in new-formations of that kind, occurring in cancer, the constituent, elementary organs display a great tendency to degeneration, and are often found broken up into an opaque mass of fat-granules. Not unfrequently, also, there may be noticed, in the papillary new-formation, a *structureless membrane*, rendered more distinct by the alkaline carbonates, and which may be regarded as a morphological product formed, either prior, or subsequently to, the cells. In general, the former case appears to be the rarer, and in fact, is observed only when extensive papillary new-formations arise on the free surface of a mucous membrane, as for instance, of the urinary or gall-bladder, of serous membranes, or of a large cystiform *areola*. In this case a cæcal, distended membrane, showing a double contour line, is observed, containing either fluid, transparent contents, or isolated cells of *cancer* of the most various kinds. The second case, therefore, or that in which the structureless membrane belongs to a later period, is to be regarded as the more frequent, as it so often happens that no common investing tunic can be demonstrated in the papillary new-formations, which consist of an aggregation of cancer-elements.

When the cancer is more highly organized, *a new formation of blood and of blood-vessels* takes place. It is beyond all doubt that red and even white blood-corpuscles may arise at completely isolated points in the growth, lying free in the *parenchyma*, without any independent walls. In a section of a cancerous tumour, blood-red spots of the most various extent are often enough seen, which in our opinion are not extravasations—that is to say, are not blood effused from ruptured vessels—for the corpuscles possess the characters of recent corpuscles in a state of development. Many of them are of much smaller size, sometimes less than half that of the fully-formed corpuscles, and unlike the latter, at this time, they exhibit no central depression. No defunct blood-corpuscles, moreover, are met with, nor any remains of the walls of blood-vessels; lastly, the above statement, that blood-corpuscles are formed independently in the *parenchyma* of the new growth is quite in accord with the observations already discussed respecting the so-termed *teleangiectases* in pleuritic exudations, &c.

In cancer, however, a new-formation of blood also takes place in the *areolæ*, which are furnished with independent walls, and in fact out of the *blastema* enclosed in them, contained in *sacculi*, and in the papillary new-formations. The independent nature of these walls can only be assumed where the line of demarcation of the blood is sharply defined even under strong magnifying powers, and when, after it has been washed away, the constituent elements of the wall appear distinct. (*vid.* pp. 82, 83.)

Virchow has also noticed groups of *blood-corpuscles contained in the cells in cancer*. These corpuscles when treated with water, yielded up their *hematin*, which was then diffused throughout the cavity of the cell, in which, after the complete removal of the colouring matter, two *nuclei* became evident. He regards it as by far the most probable supposition that the cell wall bursts, when the blood-corpuscles enter, and the wall immediately closes. Thus the appearance of blood-corpuscles is merely of an accidental nature; but we cannot avoid remarking, though the same thing is shown by Virchow's observation, how readily, on careless examination, pigment-granules or fat-globules, may chance to be confounded with blood-corpuscles.

In more highly organized forms of cancer even *cysts* are developed, particularly in many of the organs; as, for instance, in the ovary. These cysts sometimes exist in excessive quantity, so as to produce what is termed a compound cyst; or they may be found only in small, separate portions of the cancer. What has been observed on this subject in the General Part (p. 84, *et. seq.*) receives here its full application. The cyst-wall very frequently loses its epithelial investment, and its contents often fall into a state of involution at a very early period. For, especially in very young cysts, arising in the papillary new-formations, a degeneration of the *blastema* enclosed in the cavity may be observed.

A new-formation of cartilaginous and of osseous tissues, is not very rare in cancer, arising either at numerous isolated points in the growth itself, or springing from an existing bone. In the former case we have also, on one occasion, seen papillary new-formations of cartilaginous tissue seated on thick connective-tissue-bundles. When the new-formation arises from the bone, it is developed in precisely the same manner as are the cranial bones of the *fœtus*, or like osteophytes. Osseous spicules are formed, analogous to the bundles of connective tissue, and presenting like them an areolar arrangement; and even slightly ossified, papillary new formations may be seen projecting, exactly in the manner of the soft, connective-tissue formations, into the wide *areolæ*.

Adipose tissue also, occurs in cancer, either arising from the normal, original fatty tissue of the part, and thus representing a partial hypertrophy of it; or new groups of fat-cells are developed in the parenchyma of the morbid growth.

In many places, lastly, such an excessive quantity of *colouring matter* is presented in cancer, that sometimes only isolated parts of the growth, and sometimes the whole, are pervaded by it, in which variously coloured, often very large pigment-granules, appear in the contents of the cells, or may be seen lying free among the bundles of connective tissue.

Now any particular cancer may be placed in one category or another, according to the predominant stage of its evolution and the direction it takes. If a proportionately large amount of gelatinous *blastema* remain, the form is termed "*gelatiniform* cancer;" or if the *areolæ* of the *stroma* are more distinct, it is

denominated "*areolar cancer*." When elliptical, broad, unequal cells, furnished with processes, and often with several *nuclei*, and in a state of progressive, fatty, or pigmented degeneration, exist in such abundance as to constitute, when the surface of a section of the growth is squeezed, a copious, viscid or pultaceous, milky juice—not unlike crushed brain—we have the form termed "*medullary cancer*" (medullary sarcoma, cellular cancer). If the growth be mainly composed of fibrous tissue, its consistence is firmer, and it becomes a "*fibrous cancer*," though not corresponding in all respects with the *scirrhus* of the older writers.

When the fibrous bundles of medullary or fibrous cancer, in a state of retrograde metamorphosis, are infiltrated with such an abundance of fat-globules that the thicker bundles appear, even to the naked eye, as light streaks, decussating with each other, and constituting a more or less distinct net-work, the "*reticular cancer*" of J. Müller is produced; which is considered by Meckel and Virchow as a retrograde form.

In cases where a rapid decomposition of the cancerous parenchyma takes place on an internal or external surface, and it is dissolved into a fetid sanious fluid, the cancer is described as "*ichorous;*" but in using this term it should not be supposed that a new formation of pus-corpuscles takes place; for which reason, also, the expression "*suppurative cancer*" used by many authors is very wrongly applied.

If a large quantity of blood is present, either free or enclosed in vessels, the result is the "*blood*" or "*vascular cancer*" (*fungus hæmatodes*). The existence of a hemorrhagic cancer, though supported by Virchow, cannot, we think, be maintained, since, as has been stated above, the bloody spots are not, usually, to be regarded as hemorrhagic effusions.

When abundance of colouring matter exists in a cancer, and the cells, nearly throughout the growth, contain pigment, we have what is termed "*melanotic* or *pigment-cancer*."

If osseous tissue occur in large quantity in the midst of a cancerous growth, which is most frequently the case, as is well known, in the neighbourhood of a bone, the affection receives, according to J. Müller, the name of "malignant osteoid." To this form, also, belong most of the cases of *spina ventosa* of

the older writers. Gerlach has proposed for this kind the name of *carcinoma osteoides*.

When cysts are extensively developed from the papillary new-formation, or from the distended *areolæ*, there is produced the "*cystic cancer*" (*cysto-carcinoma*) of Rokitansky.

If the papillary new-formation and the dendritic conformation thence produced are strongly manifested, the cancer—to adopt Rokitansky's nomenclature—is termed "*villous.*"

If the growth be constituted, mainly (but not solely), of elementary organs analogous to epithelial cells, it is termed—to follow the same authority—"*epithelial cancer.*" A. Hannover, who erroneously denies the cancerous nature of this form, has applied to tumours of the kind in question the name of *epithelioma*; though compelled, on the other hand, to admit the existence of a combination of *epithelioma* and *cancer*. Lebert, Virchow, A. Förster, [and Bennett], term this new-formation *cancroid*; describing it as an intermediate form, approaching cancer, so far as regards its structure, but differing in the scantiness or total absence of fibres in the *stroma*. In our opinion this distinction is untenable, since in well-marked medullary cancer, places are frequently observed in which the fibrous stroma has been replaced by flattened cells. The use of the term "*cancroid,*" moreover, shows how uncertain our notions of cancer still are.

Under the name of *carcinoma fasciculatum s. hyalinum*, Joh. Müller has described a form of cancer consisting of very delicate fibres and minute cells; the growth itself being sometimes transparent, sometimes more or less opaque, and constituted of conical segments with their bases looking outwards. We have had no opportunity of forming an independent judgment with respect to this variety from personal observation, but are inclined to the opinion, that gelatiniform *sarcoma* has often been regarded as *carcinoma fasciculatum*. (*Vid.* observations with respect to the development of embryonic connective tissue in the interstitial tissue of muscles, p. 403.)

The question of the *arranging* of a given cancerous growth, under one or other of the varieties enumerated above, will often prove of an embarrassing nature. For various forms may co-exist in one and the same tumour, as is not unfrequently the case, for instance, in cancer of the breast, where the growth, in its development, in one place corresponds with gelatiniform

cancer, in another with medullary, and in a third with fibrous cancer. Thus the character is derived solely from the preponderance of the one form or of the other, as no strict, logical distinction between them exists. A similar uncertainty also arises, when it has to be determined whether any particular case should be arranged with "medullary" or with "epithelial cancer," since the growth may exhibit the characters of the former, in one place, and of the latter, in another.

The uncertainty, above adverted to, which prevails in the definition of what should be regarded as cancer, explains the existence of transitional forms, intermediate between *sarcoma* and *cancer*, and approaching sometimes more nearly to the one, sometimes to the other. Many of Lebert's fibro-plastic tumours belong to this class, and, especially, many forms of the so-termed "spongy growths" of the *dura mater*.

The diversities in the forms of cancer depend principally upon their seat, and are influenced, as is the case with all new-formations, by the parent tissue. It is well known that medullary cancer is especially prone to occur in the female breast, in the *uterus*, in the liver, in the subcutaneous connective tissue, and in the lymphatic glands; that cancer in the spleen reaches only a low stage of organization; that when seated in the *corium* of the skin, or of a mucous membrane, it has principally the epithelial character; that cystic formations are met with, chiefly in cancerous growths in the ovary and mammary gland; that cancer contiguous to the *periosteum* becomes partially ossified, &c.

The tissues which are furnished with blood-vessels can alone be regarded as capable of becoming the *point of origin* of cancer; consequently that new-formation is never found to occur in the crystalline lens, the cartilages, nails, or *epidermis*. In glandular organs, the interstitial connective tissue appears to be the starting point; this is indicated by the *lobulated configuration* of the growth, so remarkable, especially in the mammary gland and liver. But, on the other hand, it cannot be denied, that even when the growth takes place independently, on a free surface, it also presents a lobulated form.

In the *concrete form*, a strong, vascular capsule of connective-tissue is not unfrequently seen to enclose the cancerous mass, and which may be regarded as its nutritive

envelope. Opposed to this, is the *diffuse* form in which the line of demarcation of the growth is less sharply defined.

Cancer, as an organized structure, is especially subject to *spontaneous involution*, as has been explained above, with respect to the cells. This change is, in general, manifested by an accumulation of *olein*, *cholesterin*, pigment, serous fluid, and even of calcareous salts; at the same time the elementary organs of the cancer undergo a gradual shrinking—a process to which the connective-tissue-bundles offer a strong resistance. In this way are caused the well-known *cicatriform contractions*; but which, as Virchow has remarked, may be regarded, at the most, as only partial cures, inasmuch as the cancerous formation advances in other parts. The atrophy of the cancerous growth necessarily involves a collapse of the immediately contiguous normal tissue—as, for instance, of the nipple. Now if reiterated cancerous new-formations arise at the periphery of the portions in a state of atrophy, and these grow rapidly, the organization of the substance in that situation is incomplete, and often remains at an imperfect cell-formation (nuclear formation). It is these parts of a cancerous growth which are described by Virchow as being in a state of tuberculization.

When the cancer advances towards the surface of an organ, of the skin or of a mucous membrane, the fusion of the tissues is followed by a loss of substance, that is to say, a *cancerous ulcer* is formed,—the *cancer occultus* becomes the *cancer apertus*. This fusion may also take place in the interior of a parenchymatous organ, or even in the midst of a cancerous mass, in which cases irregular cavities are produced surrounded by the latter, which, of course, should not be confounded with cysts.

It was formerly, and is even still, to some extent, disputed, whether cancerous deposits be the result of inflammation, and it is well known that Broussais and his school have assumed the existence of a low degree of inflammation which they term "sub-inflammation." This theory was opposed, particularly by Lobstein, who thought that he had afforded another explanation of the matter, in assuming the existence of a caco-plastic material no longer fitted for the production of homologous structures, arising from an exalted activity of nutrition and independent of inflammation. It is evident, however, that the first question to be solved concerns the deposition of an organic

matrix—a *blastema*—out of which the cancerous new-formation originates. Whether the process necessary for the deposition of this *blastema* be termed subinflammatory, or be looked upon as one of exalted nutrition, comes to the same thing in the end. It has already been shown that inflammation may be regarded as an anomalous state of nutrition with an increased secretion of nutritive matter, in the part affected, and consequently that it is intimately related to atrophies, hypertrophies, and new-formations.

The *cancer-blastema* secreted from the blood-vessels is occasionally so abundant (as in gelatiniform cancer) as to be apparent in considerable quantity among the organized parts, whilst, in other cases, it constitutes merely a thin *stratum* of intercellular fluid.

The production of the *blastema* is attended, in many instances, with a clearly demonstrable increase in the size of the blood-vessels, which, in our opinion, is erroneously regarded as a simple dilatation. In the capillary loops of the *papillæ*, in cutaneous *cancer*, an elargement is occasionally witnessed, so considerable, that it cannot be conceived to take place without an increase of volume of the delicate, easily ruptured wall of the vessels. In this case, therefore, a *hypertrophy* of the elementary organs of the capillary vessels must exist. A similar increase of calibre may also be noticed in the smaller arteries and veins around the cancerous growth; and in many cases, in fact, an evident multiplication of these vessels is superadded, as may be seen, particularly in the nutrient capsule, composed of connective tissue, enclosing the growth. Now, if the *increased area of the lumina of the vessels* be considered, it is clear that a larger quantity of nutritive fluid will be continually afforded, and that, in one respect, this increase of the *lumina* stands in direct relation to the growth of the cancerous tumour. It may, moreover, with much reason, be assumed, that the conditions of diffusion in hypertrophied vascular walls differ from those which obtain in normal vessels, and that the transudations will naturally exhibit other characters, or, in other words, that the conditions under which the protein-compounds in the nutrient matter exist, are so modified that, instead of their simply maintaining the nutrition of the elements of any given organ, they give rise to the cancerous new-formation. That the vascular

apparatus of a cancer is exclusively connected with the arteries, or with the veins, as a distinctive character between medullary *carcinoma* and *fungus hæmatodes*, as asserted by Schröder van der Kolk, is doubted by Gerlach, who has usually succeeded in injecting the vessels in a cancerous growth more readily from the arteries than from the veins of the parent-tissue.

If, then, the question be ultimately asked,—whether, among the new-formations, cancer should be regarded as an independent growth (circumscribed by precise limits)? we are decidedly of opinion that the answer must be in the negative. In what would the independence of cancer lie?—in the deformity of its cells, whose special characters we have questioned?—in its areolar arrangement, or papillary new-formations, both of which also occur in new-formations of connective tissue, and may likewise be wanting, as well as the supposed specific cells of cancer, without our being justified in denying the cancerous nature in one part of a new-formation when it is distinctly present in another?

In this case it will be necessary, further to inquire, what criteria we may possess to enable us to judge that a new-growth is of a cancerous nature. These criteria are to be sought, not in the morphological condition of separate parts of it, but in the entire course of the evolution and involution of the organized new structure. The study of its evolution teaches us that the *cancer-blastema* (not meaning to imply, under this name, any specificality in it), may remain, in its organization, at a nuclear or imperfect cell-formation, whilst, in other places, it may achieve the development of connective-tissue fibres and papillary new-formations, of blood-vessels, bone, and cartilage. But, however great may be the organizability of the *cancer-blastema*, it is frequently impeded in its development, inasmuch as the material afforded to the elementary organs of the growth is unfit for their nutrition within the normal limits, owing to the predominance of one substance or another, *fibrin*, *albumen*, colloid, fat, colouring-matter, water, or mineral constituents. The new-formed elementary organ, therefore, falls into a state of involution, and undergoes the corresponding metamorphoses, whilst, in other places, in consequence of hypertrophy, it becomes asymmetrical and deformed. We consider, therefore, that the principal criteria by which we can judge of the cancerous

nature of a new-formation must be sought in the multifariousness of its organic development, in the size, shape, and involution of the cells, and of the substance formed by them; the remaining stationary at an embryonic stage; and in the peculiarly remarkable inequality in the stages of organization in the various tissues.

§ 1. External integuments.

In this situation the cancerous growth seems to arise in the subcutaneous connective tissue, and to extend, partly outwards, towards the true *corium* and its papillary *stratum*, partly inwards, towards the adipose tissue. The cancerous nodules here represented were taken from the abdominal integuments of a woman, who, besides several tumours of the same kind, had a very bulky ovarian cyst, whose walls were extremely thick, and beset on the inner surface with numerous nodules. Nodular cancerous deposits were also found in the liver.

The skin in the spots occupied by the nodules was half an inch thick; it was tense, smooth, shining, and dry; lanuginous hairs were visible in only very small numbers. The *corium* was firmly adherent to the subjacent new-formation, and very thin. In several sections neither sebaceous nor sweat-glands could be discerned. The *rete mucosum* of the epidermis was comparatively of some thickness, and contained pigment of a deep, dirty, brownish-yellow colour. The surface of a perpen-

Fig. 147.

dicular section of the cancer-nodule displayed the thin, marginal, membranous layer (fig. 147, *a*), and beneath this the new-growth, in which three differently coloured portions could be

distinguished, viz.: greyish-red spots (indicated by the light shading), others of a blood-colour (shown by the dark shading), and some of a light-yellow (*c* and *e e*).

The greyish-red substance exhibited, in many places, numerous bloody points and streaks, forming, by their coalescence, irregular spots, and in this way passing into the blood-red substance, which was deposited as it were in the interstices of the lobulated, greyish-red, and light-yellow portion. It was worthy of notice, also, that, in many places, the greyish-red substance became gradually of a deeper red hue, without it being possible to discern any red points or streaks in it, even with the aid of a powerful lens. We are satisfied, from the repeated examination of perfectly fresh cancerous growths which had been extirpated, that a reddish-colour, an infiltration with *hæmatin*, may exist, independently of a single red blood-corpuscle. The light-yellow substance, which was of firmer consistence, formed insulated patches imbedded in the greyish-red portion; and between their irregular boundary-lines might also be observed, dark, blood-red spots, in the middle of which were circumscribed bloody points and bifurcating streaks of the same colour, as at *e e*.

On one side of the new-growth the adipose tissue retained its integrity; the fat-cells were lodged in the *areolæ*, surrounded by connective tissue (fig. 148, *b b b*), their fluid contents being of a deep-yellow colour. But beneath them the cancerous new-formation had already made farther progress, and was separated from the subjacent muscular layer by a dense connective-tissue (at *d*). The elementary examination disclosed, for the most part, cells of small size, 0·0044 0·0052‴.

With respect to the bloody spots, two possibilities may be supposed: either blood had been newly formed in those situations, or minute extravasations had taken place, which might readily occur in the over-congested state of the thin-walled vessels. But, however much we may be inclined to admit the latter possibility, the former is also proved by the embryonic condition and minute size of the blood-corpuscles, the non-existence of necrosed forms among them; and, lastly, by the absence of blood-vessels.

The form of *cancer* here described has been characterised by many writers as "crude," "hæmorrhagic:" it is developed

with comparative rapidity, and assumes in the form of nodules movable with the skin.

A case of *cancer* more nearly approaching the *medullary form* is recorded by Professor Chiari. It was seated immediately behind the inferior angle of the *labia pudendi*, so that it was requisite to remove a portion of the *labia majora*, and of the *nymphæ*. The growth was about 1·57″ in diameter, and consistent; exhibited on the surface of a section a dirty-yellow colour, and a distinct, coarse, areolar texture. From the *areolæ*, a pultaceous material, in the form of rounded granules and soft filaments could be readily expressed; this material contained, on the one hand, mere nuclear formations, aggregations of fatty globules, a brownish molecular substance and isolated fat-globules suspended in a transparent fluid; and, on the other, minute, elliptical, oval, or elongated cells and short, fusiform fibres; the latter often exhibiting no distinct *nucleus*, whilst, frequently, two to four *nuclei* might be seen in one cell. The superjacent skin was very thin, polished and tense, and the sebaceous follicles were atrophied, or had wholly disappeared.

Gelatiniform cancer-nodules occurred in the skin of another individual, some of which were as much as 0·78″ in diameter, or more; they were seated mostly on the lower extremities, and some were covered with crusts bearing a certain resemblance to *rupia*. Deposits of the same kind existed to such an extent in the mucous membrane of the posterior *nares* as almost to obstruct them, and extended towards the *epiglottis* and the mucous membrane of the *trachea*, where they constituted extensive ulcers, covered with discoloured crusts. In the parenchyma of the lungs, and of the liver, no cancerous deposits were met with, whilst they existed in the mucous membrane of the stomach, and of the small intestine, and in the lymphatic glands. The cut surface of the cutaneous nodules was smooth, of a gelatinous appearance, and afforded, on pressure, only a very small quantity of a yellowish, slightly-turbid *serum*. The blood-vessels of the thickened *corium* were extremely congested, and dilated, which was particularly evident in the papillary loops, in which the vessels were of such a size as to be visible even to the naked eye. The cells, imbedded, in groups, in the hyaline *cancer-blastema*, were very delicate, sometimes rounded, sometimes more or less flattened, of a fusiform shape, and fur-

nished with a comparatively large *nucleus*. None of these elements were present in any great abundance. Thus, in the present case, the infiltration with the *cancer-blastema* extended also to the papillary *stratum* of the *corium;* and to this circumstance is to be ascribed its fusion, and the disintegration of the *epithelium*, and, ultimately, owing to the partial desiccation, the formation of crusts.

We have collected three instances of the *melanotic form* of cutaneous cancer. The size of the nodules varied from that of a lentil to nearly that of a walnut; and their surface was mostly subdivided into unequal lobules by shallower or deeper indentations. In one case, in a growth near the toes, this subdivision had even extended to the formation of long conical processes, exhibiting a condylomatous appearance. Each lobule of the depressed papillary elevations on the surface, covered by the *epidermis*, appeared, when cut into, to be constituted of a rusty-brown, distinctlycircumscribed group, which, when viewed from above, had usually a dirty violet, or deep-blue colour. When the *epidermis* was removed, which could only be done by maceration or the application of the alkaline carbonates, opaque, punctiform elevations were apparent on the surface of the *corium*. Vertical sections at once showed that the sessile *papillæ*, as well as the vascular loops contained in them, were considerably hypertrophied. The cut surface was sometimes smooth, and sometimes a turbid, grey fluid could be expressed from it in considerable quantity, the microscopic analysis of which, displayed rounded and flattened fibre-cells with one or several processes. The cell-contents were finely molecular, and filled with fatty granules, or were even composed solely of dirty brownish-yellow, brownish-red, or black groups of pigment-molecules. The dimensions of the cells varied, but in general those of small size predominated. In many places, moreover, the development had reached only to a nuclear formation.

In one case, that of a woman affected with similar deposits in the brain, lungs, lymphatic-glands, liver, and spleen, we noticed subcutaneous cancerous nodules of a bluish-grey colour. Closer investigation showed that the dark pigment was deposited between the atrophied fat-cells. For in the bluish adipose lobules, no fat-cells could any longer be discerned, but only larger and smaller oil-globules, between which, dark

streaks and spots were interposed (fig. 148, *a*, which represents an atrophied fat-lobule, partially enclosed by a bundle of connective-tissue-fibres). In other places, where no pigment existed among the cells, the fat was of a remarkably deep-yellow colour. The large pigment-granules cohered into irregular, larger or smaller masses, and displayed a lively molecular motion, which, in a current artificially produced, and viewed by reflected light with a magnifying power of 120—150 diameters presented a spectacle much like that shown by the pigment-granules of the eye of the Frog or of a Fish. This consisted in the rapid appearance and disappearance of bright points —a phenomenon which we conceive to depend upon the circumstance of the crystalline pigment-granules, in their rapid evolutions, turning sometimes their illuminated, sometimes their dark, smooth surfaces towards the observer. Besides this, numerous, minute elementary bodies were suspended in the turbid juice of the cancerous nodule (fig. 148, *b*), enclosing sometimes no *nucleus*, sometimes one or two (as at +). Whether the light spaces apparent in many cells should be regarded as *nuclei* in a state of serous degeneration, or as collections of a hyaline fluid in the cell-contents, remains, perhaps, in many cases, doubtful; but when a distinctly projecting *nucleolus* is seen in the sharply defined clear space, its nuclear nature would appear to be undeniable. The *areolæ* of the subcutaneous tissue were in many places of considerable dimensions (fig. 148, *c*) and crammed full of nuclear bodies.

Fig. 148.

In cancerous growths of this kind, the pigment may be observed in various stages of formation. It makes its appearance in the form of brownish-red or brownish-black granules (*hematin*), which, when they have undergone a further metamorphosis, are perhaps rendered paler by carbonate of soda,

but do not disappear, and are ultimately no longer affected by that application.

A form of cancer intermediate between the *medullary* and *epithelial* was observable in a growth extirpated by Professor Chiari; it belonged to the same woman from whose *pudendum* the medullary cancer above described (p. 540) had been removed, some months before. The cancer, which sprang up again, after the operation, extended very deeply (more than an inch) under the skin. Its consistence was in general close; and in the more loosely compacted parts, nodules might be perceived, some just visible to the naked eye, some as large as a pin's head, which were seated on the inner surface of the larger *areolæ*. On close examination, these nodules were found to exhibit a sharply defined line of demarcation, and to be invested with an epithelial covering composed of flattened cells, beneath which were others mostly of a rounded form, and containing a comparatively large, hyaline *nucleus*. In other *areolæ*, however, nothing was apparent but aggregations of fat-globules, a few granule-cells and free granular pigment. The latter, as well as the fatty globules, were also present in the connective-tissue-bundles, which were united into an areolar *stroma*. The distribution of the blood was far from uniform, and, so far as could be seen by means of a powerful lens, it was not enclosed in any independent walls; nor was there, at the same time, anything to favour the supposition that extravasation had taken place. The skin covering the growth, was polished and tense; a yellowish nodule, which could be seen shining through the surface of the integument, proved to be a small sebaceous follicle filled with epidermis-cells and a brownish sebaceous matter. In accordance with this was the hypertrophy of some sebaceous glands, but since these, as is well known, are of considerable size in this part of the integuments, it is self-evident that neither the hypertrophy nor the follicles had any necessary connexion with the cancerous new-growth; but, notwithstanding this, in the present instance, the hypertrophy might have been induced by the subcutaneous cancerous new-formation, as we have shown to be the case in new-formations of connective tissue.

The anatomical character of the *epithelial form* of cutaneous cancer, resides in its botryoidal configuration—in external appear-

ance, occasionally, not unlike a condylomatous growth—its granular texture which is usually dry, though often infiltrated with a milky, turbid juice, when it approaches the *medullary* form—and, lastly, in the predominance of frequently large, flat, angularly jagged cells, over the fibre-cells and connective-tissue-fibres.

This form of cancer is particularly apt to occur in the skin of the lips, of the *anus*, and of the *glans penis*. The cells are characterised by their gigantic dimensions, the multifariousness of their development, and the nature of the deformities presented by them in the softest parts of the growth, which are readily crushed into a pultaceous matter.

FIG. 149.

The shape of the cells has occasionally been erroneously described as simply flattened, but all intermediate forms between this and the elongated are constantly met with (fig. 149,

uppermost row of cells); their contents are finely molecular, but sometimes coarsely granular, in which case their transparency is lost; the usually solitary, more rarely double, oval *nucleus* cannot be demonstrated in many cells, and it readily escapes, owing to the delicacy of the walls. In this condition, the *nucleus*, if it have attained to a considerable size (*d*), might be confounded with a cell; which can be determined only by the reaction with acetic acid, and from the single or double *nucleolus*.

Both the cell and its *nucleus* are capable of an excessive growth; this may be observed, particularly in cancerous growths of the lip undergoing disintegration, beset with soft, discoloured nodules, and affording an extremely nauseous, mawkish odour. The irregularly jagged outline of the cell-wall, which, as a distinction between it and that of simple epithelial cells, is frequently furnished with short spicular processes, passes into one of a more rounded figure. This is manifestly succeeded by the *endosmosis* of a clear fluid; or, in other words, the cell-contents begin to degenerate, at the same time, becoming more transparent. The *nucleus*, also, which is involved in this degeneration, assumes a spherical instead of an oval shape, increasing, at the same time, in size, either together with the cell or independently of it; and occasionally it appears to be subject to a process of fusion, against which, however, it might certainly be objected that, in all probability, these cells possessed no *nucleus* at all.

But as regards the voluminous *nucleus* (as, for instance, that in the cell *c'*), it should first be ascertained whether the enclosed spherical body really correspond to a *nucleus*. Virchow regards these large, vesicular cavities in the cell as reproductive spaces (Brutraüme), in which an endogenous nuclear and cell-formation goes on. In a large cell, with granular contents, a portion of the latter, probably corresponding with a defunct *nucleus*, appeared homogeneous and as clear as water. This portion, from the first, exhibited a sharply defined, tolerably tough wall, which was very soon thickened by the apposition of new matter, and acquired a double contour. No objection can be made to the reasonableness of this view, but we think, also, that no doubt can be entertained with respect to the *nuclear* nature of the clear vesicular spaces, whenever

—as is the case in many of them—the characteristic *nucleolus* is apparent. They are referred, by Bruch, to the imbibition of water, and it cannot be denied that an *endosmosis* of this kind may produce a degree of transparency in the cell-contents; but it is uncertain whether the clear fluid in the cells of the cancer, be water, as it might, for instance, be a mucoid or colloid matter; nor, also, is there the least doubt, that the transparent fluid is surrounded by a proper membrane.

These cavities in the cells, whose *genesis* is, thus, at present obscure, occasionally possess a coarsely granular investment, and sometimes their contents are finely molecular. But we have never, so far as our present observations have extended, noticed a new-formation of *nuclei* in them, and are, therefore, of opinion that the employment of the term "reproductive spaces" must at present be suspended; at any rate, for those cavities which are filled with a hyaline or granular material, and are, occasionally, surrounded by an independent membrane.

When the examination of the cells of epithelial cancer of the lip is continued more deeply into the tissues, and the more compact nodules thus reached, flattened angular cells will mostly be observed, in shape and size not unlike those of the horny layer of the *epidermis*, but differing from them in their frequently finely jagged outline, though chiefly in the larger, granular *nucleus* containing a projecting *nucleolus*. These flattened cells, like those of the *epidermis*, are, also, superimposed one upon another in such a way that each overlaps the other to some extent (fig. 149, *e*).

In the deeper-seated layers of the growth, it usually happens, and often, also, in the more superficial, brownish-yellow portion, that nothing is met with but a molecular matter containing pigment, with larger (*f*) or smaller (*g*) *nuclei*, disseminated uniformly through it. These parts—in which, only an imperfect cell-formation has been reached, or a partial involution of the cancerous new-formation has taken place—correspond with the tuberculoid deposits of Virchow.

The *stroma* is constituted of distinct connective-tissue-bundles, exhibiting, as elsewhere, an areolar arrangement. Not unfrequently, also, minute fibre-cells, with an oval *nucleus* and prominent *nucleolus*, may be seen, assembled into bundles.

In rarer instances, cystiform cavities may be observed, with papillary growths projecting into them.

Now, in order to ascertain the mode of grouping of the flat cells of epithelial cancer and their relations with the *stroma*, it is requisite to prepare thin sections. As these cannot be readily procured from the very friable substance, in the fresh state, portions of the growth should be simply dried by exposure to the air, and the sections taken from them treated with acetic acid. In this way it is satisfactorily shown that the connective-tissue-bundles, furnished with oblong, slender *nuclei*, pointed at each end and placed at uniform distances apart, surround the groups of cells (fig. 150), by which the closed *areolæ* are completely filled. In other places nothing is seen in the *areolæ* but molecular, pigmented, nuclear masses, exhibiting the utmost multiplicity of form. The *areolæ* are of various dimensions—round, oval, clavate, &c.; and, occasionally, the section will display lateral passages. It is obvious, at the same time, that the *areolæ*, filled with the different kinds of elements, are divided in the most various directions, and that the multiplicity of their forms is due to that circumstance.

Fig. 150.

In sections of this kind, as well, also, as in portions of epithelial cancer, torn up by means of needles, in the recent condition, the elements are frequently seen disposed around a central cell, whence is produced an appearance very closely resembling that of the epidermis-cells disposed around a sudoriparous duct. In the one case, as in the other, flattened cells are disposed with their edges towards the observer, around a central point, which is regarded by Virchow as a "reproductive space." We think that, with respect to this, another fact should be borne in mind; viz., that in epithelial cancer, papillary bodies composed of epidermic cells, may be dissected out of the *stroma*, which, when cut across, necessarily display a concentric lamination, from the circum-

stance of their being formed one within the other in a pill-box fashion.

Blood-vessels occur but scantily in the morbid growth itself, and in many parts are wholly wanting, whilst, in the yellowish, brownish, gelatinous substance beneath the cellular layer, they often exist in considerable abundance. We have never had an opportunity of noticing a vascular, nutritive capsule of connective tissue enclosing the cancerous growth. Fat-globules of any considerable size are very rarely met with free, and never, enclosed in the cells; whilst in the soft, pultaceous, disintegrated parts, aggregations of fat-globules and of cholesterin plates, are found in tolerable abundance. Nervous twigs may often be traced, in immediate contiguity with the new-formed groups of cells, at the base of the growth.

A cancerous growth seated on the under part of the *glans penis* was in a state of superficial disintegration, and thus was constituted a shallow ulceration. The cancerous infiltration had extended so deeply that the anterior portion of the *urethra* was destroyed, and the urine escaped through the ulcerated spot. From the surface of a section of the growth, when removed, light-coloured, greyish-yellow, soft nodules could be easily expressed, which when broken up in water caused a milky opacity in it. The cells, which were mostly flattened and furnished with one or several slender processes, were of very various sizes, the longest diameter of the smaller sort being 0·0079—0·0110‴, of those of a middle size, 0·025‴, and of the largest, 0·0318‴. The usually oval *nuclei* were as much as 0·0079‴ in diameter. Most of the cells, especially around the *nucleus*, exhibited minute, shining molecules, which were often accumulated in such numbers that the entire cell appeared to be filled with an opaque, granular material. The *nuclei* occasionally presented a vesicular enlargement, and, on one occasion, the cell was observed to be ruptured. These flattened cells were lodged, as usual, in the *areolæ* formed by the strong bundles of connective tissue and elastic filaments. Concentrically laminated colloid-corpuscles, fat, and pigment, also occurred in many places in great abundance, and papillary growths, some as large as an intestinal *villus*, seated, with a usually slender peduncle, upon the bundles of connective tissue, could be readily dissected out by means of needles. These

papillary growths projecting into the *areolæ* were usually beset with minute, shining molecules.

A cancer, removed by Professor Zsigmondy from the lower part of the *glans penis*, was about the size of a chestnut. The *urethra* at the corresponding part was not contracted; and below the orifice several condylomatous, vascular growths, about the size of a hazel nut, projected. The nodule was firm to the feel, but when divided proved to be of softer consistence than had been supposed; it presented a granular texture, and readily afforded, on pressure, a friable matter, rendering the water rather milky, and consisting of flat cells, with large *nuclei*, and themselves, mostly, of considerable dimensions and the most various shapes. The contents of these cells were in a far advanced state of fatty degeneration. When portions, taken from the centre of the morbid growth, were torn up, several distinctly circumscribed, clavate *papillæ*, containing an opaque, fatty-granular substance, and supported on slender peduncles, were displayed. In a section of the condylomatous growths, grey, irregular, conical streaks might be perceived in the centre of each lobule, even by the naked eye, upon which the very numerous, peripheral, papillary growths were seated; the latter contained widely distended and convoluted vascular loops, which occasionally nearly filled the body of the *papilla*. When the very thick epithelial investment was removed the numerous, long, mostly straight and elongated *papillæ*, with lateral, younger formations, came into view.

In a *penis* amputated by Professor Sigmond, an ulcer existed around the *corona glandis*, having an eroded aspect. The skin bordering upon the ulcer was swollen, callous, and of almost cartilaginous consistence. The surface of the sore, in many places, exhibited scattered, greyish, depressed nodules, consisting of concentrically laminated, flattened cells (like those represented in fig. 149). The turbid coating of the ulcer, which had a mucoid aspect, contained the same kind of new-formed cells. In other places isolated, bloody specks and lines could be perceived, and in some of these parts even convoluted vessels might be seen running for a short distance on the surface. Towards the under side of the *penis* the substance was farther disintegrated, so that, in fact, little more was left, except bridge-like bands. The fluid expressed

from this part was pultaceous, and the elementary bodies contained in it, in a state of advanced degeneration. The infiltration of the callous borders was due to new-formed, flattened cells.

The form known in England as "chimney-sweeper's cancer," according to Virchow's researches, belongs to the same class as the one last described.

§ 2. Mucous membranes.

The epithelial form is that which cancer chiefly assumes in the *tongue*. With respect to the disease in this situation also, the opinion, here and there current, of its being constituted solely of flat, epithelial-like cells, but which rests upon the most imperfect research, has been entertained. A cancer situated on the base of the tongue and mucous membrane of the *pharynx*, was of soft consistence, and presented several groups of nodular eminences projecting above the surface, and covering an extent of it equal to that of a large lentil. On the surface of a section, soft, pultaceous portions were seen, constituted chiefly of flat, angular cells, with an oval *nucleus* and molecular contents

Fig. 151.

(fig. 151, *a*); some of these cells were perfectly isomorphous with the superficial epithelial cells of the tongue, and, like them, were superimposed one upon another (*b*); smaller forms

alternated with groups of elementary bodies (*d*), consisting of large, free *nuclei*, with a comparatively voluminous, prominent *nucleolus*, and of cells furnished with two, three, or several processes or *nuclei*. These perfect or imperfect elementary organs, were enclosed by bifurcating, fibrous bundles (*g*). But the *areolæ* formed in this *stroma* frequently included papillary, circumscribed groups of cells (*e e*), constituted of several systems of flat cells, disposed one within another in a pill-box fashion. Besides these, numerous rosette-like groups of cells might be observed (*f*), of which the central lay with its flat surface towards the observer, whilst those disposed concentrically around it, were viewed more or less on the edge. As has been stated before, these concentric layers might represent a transverse view of the papillary body, or of the cells enclosed in an *areola*.

In the deeper layers, groups of *nuclei*, imbedded in a hyaline, structureless substance, were alone visible. The muscular fibres in the immediate neighbourhood of the cancerous growth, presented scattered, reddish-yellow pigment-molecules on the surface; others, which had lost their transverse striation, were broken up into longitudinally striped bundles. Occasionally, also, a fatty degeneration of the muscular substance was evident, even to the naked eye. In these epithelial cancers, minute vacuities may occasionally be noticed with similar papillary structures projecting into them. In a tumour of this kind on the tongue, of the size of a hazel-nut, Hannover noticed a cavity divided by a partition, of the size and form of a small bean. The inner surface of the cavity, as well as the partition, was covered with a multitude of small, whitish-grey granules, having the appearance of minute, depressed, or pedunculated warts.

That form of *cancer of the stomach* which has been described as *scirrhus*, has been defined within narrower limits by Rokitansky and Bruch; and the difference between cancer and hypertrophy of the membranes of the stomach, has, by the latter author, been placed in the circumstance that the areolar hypertrophy of the muscular coat, which has already been discussed in speaking of "hypertrophies," is not characteristic of cancer of the stomach, and that the latter is limited to separate portions, and attended with an infiltration of all the *strata*. In a histological point of view it is impossible to lay down any

precise definition, and it is only the degenerative character of the new-formation that can allow this to be done, unless a criterion (?) be afforded in the deposition of cancerous growths in other organs.

Scirrhus (fibrous cancer) of the stomach has, for its main constituent, fibre-cells, usually in a far advanced stage of fatty degeneration, and developed in the submucous connective tissue. They constitute, together with the connective-tissue-bundles, a very close, callous tissue, from which, frequently, no milky juice can be expressed; and the elementary organs, also, are often remarkably minute. The continued advance of the morbid growth towards the glandular layer of the mucous membrane on the one side, and, on the other, towards the muscular coat, may also occur in simple new-formations of connective tissue, and should not be regarded as indicating a *cancerous* deposit. Even a destruction of the pepsin-glands, a softening of the texture, and a partial detachment of the mucous membrane, so as to give rise to ulcerations, displaying at the bottom a consistent formation of connective tissue, may also occur independently of cancer. We are of opinion that the scirrhous character is to be sought in the mode of evolution and of involution. Whilst, on one side of the morbid growth, especially in its marginal portions, the new-formation of cancer-substance continues to advance, and the subsequent outgrowths indicate a very rapid development, the central portions fall into a state of involution; whence arise, on the one hand, the radiating, cicatriform, central contractions, and, on the other, the swollen borders. In the stellate, grey streaks of the central part, besides connective-tissue-bundles impregnated with fat in a state of minute division, *nuclei*, amorphous, flaky masses, groups of fat-granules, and comparatively few, embryonic, degenerated forms of connective tissue are met with. In the nodular, marginal portions, on the contrary, the cells and groups of *nuclei* are more numerous, being more abundant in proportion as the *scirrhus* approaches the medullary form of cancer. Under these circumstances, the *scirrhus* is said to be transformed into medullary cancer, but this expression is incorrect, inasmuch as it is not the scirrhous substance itself which is so changed, but the newly added cancerous deposit which assumes the medullary character.

A striking exemplification of the coexistence of hypertrophy with a new-formation, is presented in the large growths known under the name of perforating ulcers of the stomach. In these cases, together with the scirrhous infiltration, an areolar hypertrophy of the muscular tissue will be seen around it, in consequence of which, that coat often attains to a thickness of an inch or more (*vid.* p. 196).

Medullary cancer of the *stomach*, as has been above remarked, usually occurs as a secondary product upon the scirrhous parts, and induces a rapid destruction of the mucous membrane, owing to the readiness with which its superficial portions are softened, particularly in the stomach. Hemorrhages thus readily ensue, even from the larger vessels, and the blood contained in the cavity of the stomach, dying, assumes the appearance of a chocolate-brown fluid. Medullary cancer reaches a considerable bulk, and displays a well-marked areolar tissue, with comparatively numerous, minute cells. When in a state of disintegration, the bundles of connective tissue, offering greater powers of resistance, remain in the form of finely divided fibrous shreds.

Gelatiniform cancer of the *stomach* consists in an infiltration, mainly of a gelatinous kind, of the submucous connective tissue, in consequence of which, owing to the amount of *blastema* accumulated, the pepsin-glands are elevated in groups, and separated from each other; they are also liable to a partial fusion, whence arise shallow ulcerations of the mucous membrane. The follicles of these glands occasionally enlarge, and are sometimes filled with a finely granular, opaque matter. The organization of the *blastema* is limited to the production of sometimes isolated, sometimes aggregated, elliptical, or, in some degree, angular, usually non-nucleated cells, with fine-molecular contents. Fusiform cells occur in small quantity, or are wholly wanting. Fatty granule-masses may be observed, in many places, in great abundance, and molecular masses, resembling precipitated albumen, may be perceived in insulated spots, which appear clouded even to the naked eye; these are formed in part, also, by a fine fibrous felt-work, or by rows of straight fibrillar bands. This fibrillated appearance is not lost in acetic acid, but, on the contrary, is rendered more distinct, and it may be regarded as due to the presence of mucin-fila-

ments. The rarefied, wavy, widely remote connective-tissue-bundles are not to be regarded as of new formation, but as belonging to the original tissue. In one instance, we found the blood-vessels of the mucous membrane containing scattered, brownish-red granules, unchangeable in acetic acid, and readily soluble in alkalies (*hæmatin*), and which were visibly lodged in the *lumen* of the vessel.

Instructive sections of the coats of the stomach, infiltrated with cancer, may be prepared, sometimes with the double-bladed knife, sometimes by means of the scissors, from parts in the fresh state. These sections must be examined especially under lower magnifying powers. For thin sections it is advisable to employ preparations hardened by alcohol, or which have been boiled in dilute acetic acid and dried.

An epithelial form of cancer of the stomach, consisting, for the most part, of conical epithelial cells, has been observed by Fr. Bidder.

Cancer of the *small* and *large intestines*, being seated in the submucous tissue, may extend over considerable spaces, and increase so as to form a very thick layer, without inducing any solution of the proper tissue of the mucous membrane; the latter is simply pushed inwards towards the canal of the bowel, and gradually becomes atrophied. The extended cancerous mass presents a tolerably firm consistence; its elements are small, and usually remain at the stage of rudimentary cell-formation; in many places, the walls of the blood-vessels appear to be hypertrophied, that is, the vessel becomes considerably larger, an increase, which, as a single observation teaches, does not take place at the expense of the thickness of the wall. If the cancer be more of the *epithelial kind*, nodules, as big as a pin's head, or more, are presented, most of which are flattened, wider at one end than at the other, and contain only a few fusiform cells; these nodules appear to be lodged mainly in the *corium* of the mucous membrane; they do not encroach much upon the intestinal canal, but are prone to perforate the *corium*, and thus to produce ulcerations. According to Rokitansky's observations, these forms of cancer occur only in the large intestine, and especially at the two flexures of the *colon*. The brownish-red, discoloured coating

on the floor of the ulcer consists of a molecular matter mixed with remains of the tissues (organic *detritus*).

A *gelatiniform cancer*, seated on the wall of the *rectum*, and which was extirpated by Professor Schuh, displayed, when cut into, light-yellow, transparent masses, 0·44—0·88‴ in diameter, and lying at tolerably uniform distances apart. These masses could be readily squeezed out by pressure with the scalpel, and exhibited a viscous, gelatinous, colloid-like, compressible material. Of organic constituents, this matter contained mostly elliptical cells, with a large, oval *nucleus*, and prominent, shining *nucleolus*; and, frequently, two or several *nuclei* might be seen in one cell. The uni- or multi-polar cells were isolated and scattered, whilst the elliptical were grouped together. The fatty degeneration of the contents of the usually voluminous cells was far advanced, especially in those places which appeared opaque to the naked eye. These organic elements were lodged in a hyaline blastema, which was enclosed in a well-marked areolar, fibrous *stroma*.

The more intimate structural analysis of this *stroma* disclosed the existence of comparatively, widely distended *areolæ*

Fig. 152.

(fig. 152, *c c c*), subdivided by projecting fibrous bands into smaller loculaments; these *areolæ* of the second order were

again subdivided, in a similar manner, into others of a third order, and so on. The fibrous bundles appeared, at first, finely pointed, and projecting free into the *areola;* ultimately, however, they became united with others, and in this way formed the fibrous network. A second remarkable formation was that of the papillary kind; this assumed, sometimes, the form of merely a depressed truncated eminence, sometimes of an extensive clavate vegetation, which either presented a sharply defined outline, or, at its rounded extremity, a fibrous bundle, projecting in the form of a pointed process (*vid.* the *papillæ* at *a* and *b*). These hemispherical, bluntly conical, club-shaped projections consisted of embryonic connective tissue, whose elements were very minute. In many of them, even a rudimentary cell-formation did not seem to have been attained to, inasmuch as they contained merely a fatty, molecular substance.

On the mucous membrane in the lower part of the *rectum,* we observed an epithelial form of *cancer.* In this case, the papillary growths especially, were very numerous, and contained morphological elements, consisting of minute, flattened, polygonal cells, with a comparatively large *nucleus,* and not unlike epithelial cells. Larger, flat cells were noticed only on a few papillary vegetations. The latter were also seated in great number, and over a considerable extent of surface, on the skin surrounding the *anus,* where they constituted, by their union, condylomatous growths, resembling, in all essential particulars, those described as occurring on the *penis* (p. 584). It was, moreover, worthy of remark, in a morphological point of view, that lighter-coloured, less resistant spots, some as large as a lentil, were apparent under the skin, affording a turbid, puriform juice. No pus-corpuscles were observed in the course of the examination, but simply, together with much free fat in state of suspension, minute nuclear bodies beset with fat-molecules on the outside.

On the mucous membrane, especially of the urinary bladder, those forms frequently occur, which were first recognized by Rokitansky, and minutely described by him as "*villous cancer.*" A well-marked instance of this form of cancer was removed by Professor Schuh; it was attached to the nasal mucous membrane, and projected into the *antrum.* The

tumour, which was about the size of a walnut, was seated on the bone, so closely, in fact, that it was necessary to remove a part of the latter at the same time. The texture was in general soft, but in several places in the section the areolar type of tissue was very distinctly recognizable. In thin sections, numerous red points might be noticed; in but few places had the development of vessels been attained to.

The most interesting portion of the morbid growth consisted in the very numerous rounded protuberances, which could not be seen without the aid of a powerful lens, nor their outlines distinctly shown without that of the compound microscope. These processes were either seated, immediately upon the areolar, trabecular tissue, or sprang from a branching stem of considerable thickness (fig. 153). They might be divided into the *solitary* (*b* and *d*), and the *grouped* (*a a*). As regards their shape, simple and compound forms might be remarked, the former presenting a comparatively broad, or a narrow basal portion, a longer or shorter, slender neck, and a globular or ellipsoidal head. The more compound forms were produced by lateral indentations and tuberous elevations. And as regards their disposition, papillary formations might be seen, grouped in an umbellate or fasciculate manner, arising from the stem or branches under a more or less acute (*b*, *c*) or right angle (*d*). The size of the latter was very various; the transverse diameter at the broad, clavate end varied between 0·02—0·088‴, and the long diameter between 0·031—0·044—0·132‴; the longer ones had a slenderer neck.

Fig. 153.

They consisted of young connective-tissue-elements with well-marked, comparatively large, oval *nuclei*, in which were visible 1—2—3 brilliant *nucleoli*. The more transparent, thin-necked processes, contained fusiform cells, disposed parallel with the axis, and, in the firmer papillary growths appearing to be transformed into wavy connective-tissue-fibrils, together with a very delicate, elastic, filamentary network. Most of the *papillæ* contained a larger or smaller amount of fatty molecules, suffering no further change in acids or alkalies, and which, as in all similar structures, were accumulated more especially towards the rounded ends of the *papillæ*, causing a diminution of the transparency in that part.

From a portion of the tumour not furnished with *villi*, a well-marked medullary juice could be expressed, including cells in a state of incipient fatty degeneration, mostly rounded, though some were furnished with processes. The former were 0·0061‴ in diameter and the *nuclei* contained in them 0·0031—0·0044‴; whilst the length of the elongated cells amounted to 0·023—0·0318‴. Lastly, also, flattened, multangular and elongated cells, with 2—3, or several oval *nuclei*, might be seen.

On the mucous membrane of the urinary bladder of an old woman who had suffered under *cancer* of the *uterus*, and had at the same time several tuberculous [?] abscesses in the lungs, there were visible, at the point corresponding to the *caput trigonum*, some nodules about 1·32‴ long; some of a light-grey colour, and others dotted with red, whose clavate shape could be readily perceived, even by the naked eye, when they were floated out in water. Under these circumstances they could at once, with the aid of a lens, be recognized as compressed, discoid, oval, club-shaped, papillary growths, having longer or shorter peduncles, and either isolated or standing in umbellate groups, seated immediately on the mucous membrane, especially around the openings of the *urethra*, or upon a stem springing from the *corium* of the membrane, and subdividing into short branches. The *papillæ*, marked with bloody dots, contained a beautifully perfect, vascular *plexus*, especially at their rounded extremities, which was wholly wanting in those of a milky aspect, whilst in the smaller ones, at most, a bloody point only could be seen.

Closer examination of the clavate processes showed that

they were covered by *epithelium,* whose cells manifestly belonged to the forms comprehended by Henle under the name of transitional *epithelium.* They were flattened, more or less angular cells, furnished with one, two, or three processes usually apparent on one side, having a distinct, oval, granular *nucleus,* and transparent contents.

When the *epithelium* was stripped off, a delicate, hyaline *stratum* was seen, thrown into folds like a structureless membrane; but which, when torn up, appeared to be composed of very delicate fibres. Within this enveloping membrane, nothing but blood-vessels and embryonic connective tissue in a state of fatty degeneration could be noticed (fig. 154). The former were numerous, and consisted of comparatively thick trunks, which soon diminished in size in consequence of their giving off branches under various angles. The thicker vessels exhibited numerous saccular protrusions, whilst the smaller followed a more rectilinear course (*a*). The structure of these vessels was characterised by its simplicity; even in the largest of them no elastic nor longitudinal fibrous layers could ever be observed; the wall, exactly like that of the capillaries, consisting of a membrane in which oval *nuclei* were apparent at certain distances apart. The contents of the vessels, besides red blood-corpuscles, consisted of numerous white-corpuscles, which in many places obstructed the *lumen* (*a′*, *b.*)

Fig. 154.

The embryonic connective-tissue-elements lay isolated, among the blood-vessels, most of them having a rounded or fusiform figure. The rounded elements were, not unfrequently, in such an advanced stage of fatty degeneration, that even the clearer spot corresponding to the *nucleus* had disappeared, and the round connective-tissue-cell had become a "granule-mass."

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gelatinous or medullary nodules. We have had several opportunities of examining gelatinous forms of cancer on the *peritoneum*; they have usually been transparent nodules of a pulpy consistence, and of considerable dimensions, (growing to the diameter of some inches,) from which, by means of scissors, instructive sections might be readily made. The *stroma,* which, even to the naked eye, was manifestly areolar (of the kind shown in fig. 152), was wholly wanting in many places; and it is to these parts of the growths that our attention will be, here, especially directed.

In a perfectly structureless, hyaline *blastema,* isolated groups of elementary organs were apparent, which were concatenated together, sometimes in a circular manner, sometimes in convoluted lines, and, as they were disposed in various planes, could be traced only by the altering of the focal distance. The groups were about as far apart as *a* and *b* in fig. 155. The

FIG. 155.

elementary bodies themselves, were of a sub-oval shape, had a distinct cell-wall, and occasionally coarse-granular contents; the existence of a *nucleus* could not be made out in most of them, even after the addition of acetic acid—they were, therefore, non-nucleated, unless the lighter spaces perceptible in the cells might, perhaps, be regarded as indicative of the incipient formation of a *nucleus*. These groups of cells (*a*) appeared to

arise spontaneously in the *blastema*, like points of crystallization.

In other groups (as at *b*), one or more fusiform cells might be seen, applied to their periphery, from which was given off an elongated, delicate filament, lying in contact with the peripheral cells. The fusiform cells (*c*) had bodies of the most various sizes, were sometimes wider or slenderer, and furnished with 1, 2, 3 *nuclei*. The latter class of cells were, moreover, disseminated in various directions, in the hyaline *blastema*, unconnected with a group of oval cells, so that there was no reason to suppose, that the fibre-cells were produced from the oval. We are of opinion, therefore, that these *fibre-* or *fusiform cells* must be regarded as of *independent origin*, and as *formed out of the blastema*.

From them is produced the fibrous connective tissue (as at *d*), partially enclosing the groups of cells. In the *areola* on the left hand, in this figure, three of the larger kind of cells are represented, two of which present fine-granular contents, and a parietal, fibre-like, elongated *nucleus*, whilst the third cell contains a coarse-granular material on the one side, and on the other a transparent substance.

In a few places, club-shaped *papillæ* projected from the arched connective-tissue-bundles, free, into the cavities of the *areolæ*. These *papillæ* were of various sizes, and, in the first stage of development, presented delicately granular contents, in which *nuclear* bodies were visible. Occasionally two clavate *papillæ* were seated on a common stem (fig. 155, *e*); (*vid.* what is said upon this point, pp. 79, 80).

In the less transparent, or nebulous portions of this kind of gelatiniform cancer, the elementary organs are more abundant; and not unfrequently the development does not advance beyond a rudimentary cell-formation, or the new-formed cells degenerate, fat- or pigment-molecules being deposited in them; it would even appear that they enlarge by the reception of a transparent fluid from the *blastema*, and sometimes, in consequence of this, may exhibit the clear spaces before noticed, in their interior. The papillary growths may also degenerate in the same way as the cells, and Rokitansky has even noticed incrustations on them. The *blastema* is likewise subject to a similar retrograde metamorphosis; when

aggregations of fat-globules are found in the *areolæ,* and numerous, larger and smallerf at-globules cover the *trabeculæ* of connective-tissue. In many places, numerous colloid masses are deposited from the *blastema,* presenting the aspect of flat, amorphous, friable corpuscles, which remain unchanged in acetic acid. Concentric or radiated colloid-bodies are met with in comparatively small numbers.

At the same time, *all* the fibrous tracts in gelatiniform cancers of this sort, should by no means be regarded as consisting of connective-tissue-fibres, for they are seen in many places, where not a single fibre-cell is evident, and similar fibrillar appearances may be artificially produced by the action of acetic acid. These are due, in fact, to nothing more than mucin-filaments, characterized by their straight course, and the very delicate filamentary net-work, visible only under a strong magnifying power, formed by them, which morphologically resembles that of *fibrin,* though differing from it chemically; not only in its resisting the action of acetic acid, but on the contrary, by its being, as it were, evoked into existence by that reagent, in which coagulated *fibrin* is rendered gelatinous and invisible. If a cancerous growth of this kind be boiled in dilute acetic acid and thin sections be taken from a dried preparation thus made, the fibrous *stroma* will be shown in the most distinct manner, as it is, also, in old preparations in alcohol.

The *medullary form* assumes, as is well known, the shape of *nodules* or *tubera* of the most various dimensions; the medullary juice often contains merely a few elliptical cells with large *nuclei* and prominent *nucleoli;* the *nuclei* are usually of an oval form, contain a few granules in their interior, and are surrounded with a closely adherent, though not very sharply defined substance. Acetic acid causes them to shrink. The substance interposed between these *cells* and *nuclei* is composed of minute, fatty molecules, which float on the surface of the water, together with fatty granule-masses, and delicate, dull-looking molecules, resembling those of precipitated *albumen.* Very scanty traces of a fibrillar structure are perceptible.

The pigment, which is apparent under the form of brownish-black and reddish, large granules, exists occasionally in such abundance in these medullary cancers, as to give them a

dark colour, when they pass into what is termed the *melanotic* form.

We have only once noticed the occurrence of *villous* cancer on the *peritoneum*. There were extensive cancerous deposits in the *omentum* and *uterus*, and a copious bloody exudation in the abdominal cavity. In the cancerous masses which might be raised like a false membrane, roundish, fine-granular cells, with a parietal *nucleus* and projecting *nucleolus*, could be perceived. In these cells the *nucleus* occasionally appeared to be wholly wanting, and sometimes two or three might be seen in each cell. The fibre-cells with oval *nuclei* were assembled into bundles, giving off lateral branches, which projected freely into the abdominal cavity like terminal rows of cells, and constituted the slender filaments visible on the free surface of the false membrane. The deeper layers consisted of a dirty-yellow, filamentary net-work, having pigment-granules disseminated through it, and from which, when torn to pieces, papilliform, dark, granular, sharply defined corpuscles were occasionally liberated. It cannot be doubted, that the latter are analogous with the bodies found by Rokitansky in false membranes, and described by him as "hollow clavate bodies." Rokitansky notices villous, vascular growths, containing a medullary juice, as occurring particularly on the *peritoneum* of the small intestine, together with numerous cancerous nodules in the liver and *omentum*.

§ 4. On fibrous membranes.

It is well known that tumours occurring on the *dura mater* were, formerly, all comprehended under the general name of *fungi duræ matris*. The question whether they should be referred to *cancer* or to *sarcoma* has, we conceive, been put in too general terms, and we think that Lebert, and with him, Virchow, are wrong in denying the cancerous nature of *all* these tumours. With reference to this we cannot conceal from ourselves (as has been already stated) that the proper definition of what is cancer is as yet by no means established. Lebert appears to us to fail, particularly in this,—that he enumerates these soft, mostly very vascular tumours, under *cancer*, because they usually contain cells presenting all the characters assigned

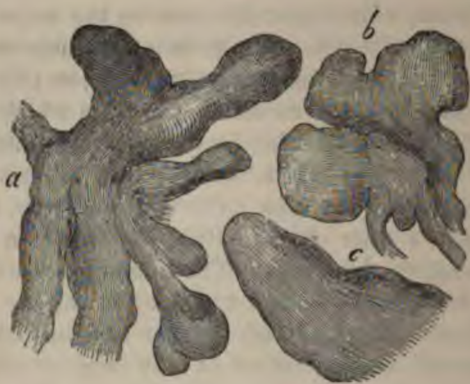
by him to the so-termed cancer-cells. The absence of the milky juice, and of the central softening, and their solitary occurrence, are insufficient, in his eyes, to exclude them from cancer.

Those delicate, villous growths seen on the inner surface of the *dura mater,* but which really arise in the subserous tissue of the *arachnoid,* are to be regarded, decidedly, as of a cancerous nature. Rokitansky has recorded a case in which a tumour, of the size of a hazel-nut, was seated on the inner surface of the *dura mater,* above the left anterior clinoid process. Besides this, there existed, in the same subject, large fibroid tumours in the *uterus,* and a mass of medullary *carcinoma* in the right kidney, as large as a hen's egg. The tumour on the *dura mater* presented a botryoidal surface and greyish colour, and, when cut across, exhibited a radiated, fibrillar structure, which arose from a mass of denser tissue at the base of the tumour, and was distinctly indicated by the corresponding course of the blood-vessels. The skeleton of the tumour consisted of a villous structure, equal in length to about two thirds of the diameter of the growth, and which rose from a basis constituted of a close, felted mass of fibres slightly interwoven with the *dura mater.*

We observed a precisely similar structure, in a large growth situated on the falciform process of the *dura mater.* Its section resembled that of an acinose gland. The papillary growths, which were readily displayed by maceration, were seated, in groups, upon tolerably thick *trabeculæ* (fig. 156, *a*), had a broader, or narrower base, and occasionally exhibited a neck-like constriction; they were simple, or furnished with smaller lateral nodosities; in many places they presented a nodular conformation (*b*), or one resembling that of the intestinal *villi* (*c*). Their length varied between 0·07—0·29‴, and breadth between 0·053—0·070‴; and, at the same time, they were manifestly flattened. Occasionally, a delicate fibrous bundle might be seen passing from the point or from the side of some of the *papillæ,* which bundles, most probably coalesced with others of the same kind, and were destined for the increase of the trabecular tissue. The foundation or central part of each of the larger *papillæ,* was formed by a fibrous bundle, around which were disposed, sometimes oblong, sometimes elliptical,

thin-walled cells, with a large, excentric *nucleus*. Blood-vessels could not be seen in any part of the *papillæ*. The *trabeculæ*

FIG. 156.



consisted of slender, fusiform cells, with oval *nuclei*, and, when further developed, presented delicate connective-tissue-bundles.

A tumour, about the size of a small hen's-egg, growing from the *dura mater* into the anterior half of the left cerebral hemisphere, we also think, must be regarded as of a cancerous nature.

When cut into, it had a medullary aspect, was consistent, spotted with red, and, in the softer parts, of a yellowish hue; occasionally, however, the yellow portions were of firmer consistence, and, on the whole, bore some resemblance to portions of cancer in a state of involution. The cells, which, in many places, could be expressed in considerable quantity, in the form of a turbid juice, had sometimes a flattened figure and fatty, granular contents, but, for the most part, were furnished with one or two elongated processes. Cells with several *nuclei* (three to six) were comparatively rare. The principal mass was constituted of bundles of fibre-cells, with an oval *nucleus*, a prominent *nucleolus*, and having the two opposite processes running out into a wavy, convoluted filament. The bands of connective-tissue-bundles formed the proper *stroma*, and were rounded off here and there into villous eminences, standing in groups.

Considerable interest attaches to the development of blood-vessels, both in this tumour, and in another of the same kind, consisting of two lobes about the size of a walnut, which was situated at the base of the *cerebellum*, and had compressed the *medulla oblongata*. The bloody points visible to the naked eye, were seen, with the aid, merely, of a powerful lens, to be sharply defined, irregularly sacculated corpuscles. Closer examination of their structure showed that these were closed *sacculi* (fig. 157, *a*), with walls composed of a lax, embryonic

Fig. 157.

connective tissue, with imbedded, oblong *nuclei*. The cavity was abruptly defined by the closely crammed, red, blood-corpuscles. The prolonged portion of the *sacculus* was occasionally enlarged, by the addition of one, or of several, lateral protrusions, into a sort of secondary sac (as at *b*), or the numerous processes, furnished with varicose dilatations, were

continued to a greater length without giving off branches, or ultimately became dilated into an irregular sacculated *diverticulum* (*c*). Occasionally, also, blood-vessels might be seen as much as 0·052‴ in diameter, running in abrupt curves, presenting numerous lateral, rounded protrusions, and, in their winding course, becoming suddenly reduced to a half, or even to a third of their original calibre. The loops formed on these arching vessels might, on superficial examination, be taken for cæcal protrusions; but this error was corrected by a more accurate adjustment of the *focus*, and especially after the part was treated with water and acetic acid, the greater transparency arising from the removal of the red blood-corpuscles then allowing the turn of the loop to be more distinctly seen. The walls of the blood-vessels never exhibited any transverse fibrous layer, but merely elongated *nuclei*, placed at certain distances apart, and disposed in the long axis of the vessel, and which doubtless belonged to short fibre-cells.

With regard to the theory of the origin of these blood-containing *sacculi*, we must refer to what has been said in the General Part, (pp. 79 and 82), and at the same time would remark, that the excessive productivity of the cells, witnessed more especially in cancer, is also manifested in the fibre-cells of the walls of the vessels, and in the densely crowded multitudes of blood-corpuscles. The latter arise in the *blastema* which is enclosed by the groups of fibre-cells. The red-corpuscles presented a greater disparity of size than is usually observed to exist in ordinary blood. The majority were of small size, without the central discoid depression, and of a pale colour.

Besides the sanguiferous *sacculi*, others also existed, exhibiting a clavate, cæcal, terminal enlargement, and fine-molecular contents (fig. 158, *a*). When traced further, these were found to constitute a network composed of bifurcating, much convoluted tubes (*c c c*), filled with similar contents. But in other tubes, both larger and smaller, the contents appeared to consist of fatty granules; and the individual fat-globules occupying the entire *lumen* of the tube reached a diameter of 0·00026 — 0·00354‴. The fine and coarse granular contents in other similar tubes, with rounded, villus-like ends, or in their prolongations, formed merely a central, slender tract (fig. 158, *b*). No *nuclei* could be perceived in the

walls of these tubular structures, even after treatment with acetic acid, the substance of which they were composed appearing to be homogeneous, and furnished with nodular enlargements.

Fig. 158.

Now what do these structures represent? Their homogeneous, fine-molecular or fatty contents, certainly bear some resemblance to lymph, but we hesitate before ascribing to them the nature of lymphatic vessels, notwithstanding their mode of ramification, since they do not possess the nodular enlargements peculiar to the lymphatics (at any rate, the forms *a* and *c*). At most, would those represented at (*b*), alone, seem to correspond with lymphatic vessels.

A tumour situated at the base of the brain and extending from the left internal auditory *foramen*, to the *amygdala* on the same side of the *cerebellum*, was of an oval form and about the size of a small citron; its surface rendered lobulated

Fig. 159.

by bulging eminences (*vid.* fig. 159, *a a*), was smooth, shining, and of a dark cherry-red colour, passing into a dirty yellowish-

red. Comparatively large blood-vessels might be seen running on the periphery of each lobule. At the part corresponding to the *meatus auditorius internus*, the tumour was intimately connected with the acoustic nerve (*c*). The corresponding cut surfaces (*b b*) of the divided tumour, also displayed a lobular arrangement in their interior. A variety of colours was observed in many places, grey and reddish-yellow alternating with bloody streaks and dots, the latter of a very deep hue. The consistence was about that of the normal thyroid gland. The scanty juice expressed from the substance of the tumour was slightly nebulous.

The numerous bloody points proved to be either vessels cut across, or to correspond with cæcal cavities enclosed by delicate connective tissue, and assuming divers forms like those shown in fig. 157. The *lumina* of the vessels were comparatively wide, and lateral *diverticula* were frequently apparent. The cells composing the proper parenchyma of the morbid growth were of small size, oval, and furnished with one or two, short processes and a *nucleus*. In the softer portions, the cells were about twice as big, and in those situations, numerous fatty granule-masses, with many isolated fat-globules, disposed in layers, might also be perceived; in such abundance in fact, as, in thin sections, to constitute opaque masses. In the more consistent, deep yellow parts, orange-yellow pigment was accumulated in considerable quantity, and from these parts, when torn up, hyaline, amorphous plates, (colloid ?) were liberated. The *stroma* appeared to be constituted throughout of connective-tissue-bundles crossing each other in various directions. In the yellow, clearer, transparent, and almost gelatinous lobules, tubular canals, united so as to form a net-work, were apparent, filled with a fine-molecular substance, (fig. 160). These vessels presented all the characters assigned by Kölliker to the lymphatics, and corresponded with those observed by us in œdematous adipose tissue. We may, here, be allowed to remark that the structures described and figured by Förster as the villous commencements

FIG. 160.

of newly-formed lymphatic vessels, in a *sarcoma* of the spinal marrow, might, perhaps, have been nothing more than Rokitansky's dendritic vegetations.

Now, with respect to the designation of this tumour, we find applied to it the names of:—*fungus hæmatodes* (of the older writers), "fibro-plastic tumour," (Lebert), *sarcoma*, (Virchow), and *cancer*, (Rokitansky). Virchow has been induced to dispute the cancerous nature of these tumours, principally upon two grounds—that they occur solitary in the organism, and do not exhibit any central softening. We have already stated that these reasons cannot be regarded as sufficient, and think that it is impossible, with our present vague notions respecting the last-described form, to arrive at any decisive conclusion. Reasons for ascribing to them, at any rate a relationship to cancer, are afforded by the spontaneous, fatty, and pigmented involution in the central parts of the tumour, and the excessive (as regards size and number) formation of blood-vessels.

5. Bone.

Many forms of *cancer* are met with in the bones, which, as everywhere else, do not occur exclusively, each by itself, but usually in combination. The *gelatinous form* arising *from the periosteum*, has twice occurred to our observation. In both cases it consisted of numerous large tumours, presenting a coarse, lobulated aspect, arising from the existence of deep, widely distant indentations. The capsule of the fluctuating lobes, which had attained to about the size of a man's fist, was in many places of cartilaginous density. The smaller, younger tumours arising from the *periosteum*, seated upon a comparatively broad base, were less transparent, and of softer consistence.

The surface of sections displayed various conditions; the fundamental character remained that of the well-known areolar texture, but this in many places was partially destroyed, and no longer recognizable. The viscous, tenacious juice, sometimes also of a gelatinous consistence, was in other places, by the reception of water, converted into a thin, transparent fluid, and

in this condition was often enclosed in considerable *areolæ*. Besides this, spots having a bloody tinge, or of an almost cartilaginous consistence, might be observed.

In sections of due thinness, which could be readily prepared by means of the scissors or scalpel, rounded or elongated groups of granular cells could be perceived, lodged in a transparent, structureless, intercellular substance, which gradually assumed more and more of a striated texture, appearing in fact, to be disposed in concentric layers around the corresponding groups of cells. Upon the addition of acetic acid the formation of thêse layers might be distinctly noticed, where they were inapparent before its application. Under these circumstances, also, nodular, slender, elongated enlargements became visible in the artificially produced fibrous layers, which have formerly been erroneously described as fibre-cells; but as it is impossible that cells of this kind could be produced in a structureless material by the action of acetic acid, we think we are justified in esteeming them *not as nuclei at all, but as a coagulated substance*. For even in rapid crystallization, as, for instance, of common salt, sal ammoniac, &c., nodular enlargements may be seen to arise, from which the solidified substance thins off on both sides.

This fibrillar formation, produced by the precipitation of the fluid *mucin*, occurred in many places so abundantly, that the cells appeared to be quite overwhelmed by it. In many parts the latter were in an advanced stage of fatty degeneration, and transformed into fatty granule-masses. These places were perceptible, even to the naked eye, as milky white spots, which were in part also referrible to the accumulation of free, fat-globules, and of a fine, brownish-yellow, molecular substance. Reddish-brown and black, amorphous, lumpy masses were likewise seen imbedded in the substance, probably new-formed blood in a state of involution, since *areolæ* might also be observed filled with blood in the normal condition.

In one instance, numerous *osseous* new-formations projected from the inner surface of the *ilium*, which when examined with a lens after maceration and drying, exhibited the utmost diversity of form. They were characterized, generally, by the delicacy, softness, and porosity of the osseous rays, which were arranged essentially on the areolar type,

though even in this respect, innumerable varieties were displayed. A cribriform aspect was given to these neophytes, when the *areolæ* corresponding to the medullary *cancelli* of the spongy bones, were of pretty nearly equal size, and placed at tolerably uniform distances apart. Into these *areolæ*, projected, sometimes pointed, sometimes truncated, occasionally dichotomous processes, precisely resembling those papillary growths which grow from the *trabeculæ* of the soft cancerous *stroma* into the *areolæ*, (*vid.* fig. 152); it may, therefore, be said with perfect correctness, that the osseous framework corresponds in all respects with the soft *stroma*; the same embryonic connective-tissue-elements, moreover, being contained in the one as in the other. In many places, *cystiform* cavities were formed by the deficiency, and, as it were, mutual suppression of the arching osseous rays, which were filled with a nuclear, fatty substance, rendering the water milky.

A foliated, areolar aspect was produced when the osseous substance was disposed in straight, finely-perforated *lamellæ* standing at certain distances apart. The latter, under these circumstances, mostly terminated in acute spinous processes.

Lastly, in macerated fragments of this bony structure, very delicate, transparent, occasionally perforated membranes might be noticed stretched across the *areolæ*, but by no means completely closing them, which were immediately continuous with the bone and structureless. The osseous tissue close to the borders of the rays consisted of oval elements resembling cartilage-cells; the bone-corpuscles, according to the degree of their evolution, were angular, or furnished with distinctly radiating and bifurcating *canaliculi*. The intercorpuscular substance appeared, sometimes streaked, sometimes finely punctate.

It is well known that *medullary forms of cancer* also, are developed from the bones, in which, numerous, occasionally widely-spreading osseous rays, extend from the bone into the tumour. A case of this kind came under our notice in the *cranium* of a boy twelve years old. The *fungus* was situated on the outside of the right frontal bone, arose from the *periosteum*, and extended backwards as far as the squamous portion of the temporal bone. The osseous spicules, seated on the

outer table of the frontal bone, were parallel to each other, and extended to a distance of from 3·54—4·4‴ into the fungous growth, some slender, bony *lamellæ* penetrating still more deeply into it. On the anterior part of the right side of the *basis cranii*, a similar, jagged osseous mass, projected inwards towards the substance of the brain. The medullary morbid growth consisted, chiefly, of variously shaped *nuclei*, oval, biscuit-shaped, or of a trefoil form, which occasionally cohering together, constituted, as it were, an ill-defined, peripheral substance; they shrank a little under the action of acetic acid, but their original form was unaltered. These numerous, nuclear bodies, contained 1—2—3 prominent *nucleoli*, together with delicate granules, which did not convey the optical expression of fat-globules. Fully formed cells, with an investing membrane, were but rarely apparent. *Olein*, in a state of minute division, might also be seen in many of the fatty granule-masses. The osseous substance presented the same conditions as existed in the former case.

In the latter case, therefore, the new-growth seems to have been developed, as it were, in two directions. On the one hand, we see a gelatinous, and on the other a medullary form of cancer, attaining to a considerable bulk, whilst in both instances immature osseous-substance was developed from the bones. May not this twofold type of formation originate in the different kinds of vessels from which the growth receives its *blastema?* The vessels of the *periosteum* communicate, on the one side, with those of the lax investing connective tissue, and on the other, with those proceeding from the cortical substance of the bone; affording, in the latter case, the nutriment for the peripheral part of the bone, whilst in the former, they subserve the nutrition of the elementary organs of the connective tissue.

When the cancer is seated *in the substance of the bone*, its growth usually continues at the expense of the latter, and a rarefaction of the osseous tissue is the result. Or the parts of the bone enlarge, together with the cancerous substance, and become the osseous framework of the morbid growth. Among the different forms of cancer, as it occurs in bones—the gelatinous (areolar), medullary, fibrous, epithelial, and melanotic—the first and last, as is well known, are very rare. The *fibrous form* of *cancer* was apparent in several of the ribs of a woman

who had numerous cancerous nodules in the liver. The nodules of the morbid growth were some of them as big as a walnut. The sub-rotund cells reached a diameter of 0·004—0·007‴, and the comparatively large *nuclei* measured 0·004—0·005‴, (fig. 161, *a*). These cells were not numerous, and alternated with the binucleated and oblong kind (*b*), which latter presented 1—4 processes, and gradually diminished in size. The connective-tissue-bundles (*c*), of considerable dimensions, must also be regarded as of new-formation, for bundles of such a thickness are never observed in the *medulla* of the ribs under normal circumstances. Elastic fibres could not be perceived.

FIG. 161.

Yellowish-brown, or black groups of pigment-granules were scattered, here and there, throughout the fibrillar tissue. The flattened, irregularly jagged corpuscles, occasionally covered with a few granules (*d*), would seem, most probably, to be colloid plates; they were unchanged by acetic acid. Their differential diagnosis, from accidental *epidermis-cells*, consists in their diversity of size and shape, and in the circumstance of their not swelling in acetic acid nor in diluted alkalies. Lastly, there were apparent numerous flattened bodies with several (4—20) oval *nuclei*, with regard to which, it is perhaps extremely doubtful, whether they should be regarded as multinuclear cells. In any case they are analogous to the large corpuscles discovered by Kölliker in the fœtal marrow of the *tibia* in a child one week old. On account of their great number, they must, we think, at any rate, be viewed as pathological new-productions, and, in accordance with Kölliker's opinion, be described as embryonic forms. The osseous tissue was destroyed in the parts infiltrated with the cancerous matter.

The *medullary form* appearing as a reddish-grey, thick, grumous substance occupying the *cancelli*, though not distinctly circumscribed, consists of chiefly round cells with large *nuclei*; the fibre-cells are scanty, whilst there is abundance of free

fat, and numerous fatty granule-masses. The neighbouring *medulla* is often of a deep red colour. It is well known that the affected bones, under these circumstances, lose some of their rigidity, and acquire a certain degree of flexibility. This is the case, in a more marked degree, when the medullary cancer appears, not as a circumscribed growth, but as a more or less dark-red, dirty, thin pultaceous substance replacing the marrow. In cancers of this kind, round elementary organs are chiefly met with (*vid.* fig. 112, *c*). The softened, flexible, osseous substance, when viewed in thin plates, no longer presents the normal structural condition; the intercorpuscular tissue assumes a broadly striped appearance, the *striæ* decussating in various directions; the bone-corpuscles appear at first as light spaces, and are ultimately wholly unrecognizable in the fissure-like vacuities. After the application of diluted hydrochloric acid, the striated texture of the softened bone is rendered far more distinct than it is in the normal condition.

The *epithelial form* is characterized, as in other tissues, by the granular texture; the individual granules of which it is composed may be the more readily expressed in proportion as the morbid growth is of softer consistence. The majority of the cells composing the growth are of the flattened kind, and in many places their forms have a surprising resemblance with those of the oral *epithelium* (fig. 162, *a*); but on the comparison of a considerable number, the jagged outlines above described will be remarked. Moreover, in cancerous growths, of this kind, large, flattened corpuscles with jagged processes and numerous *nuclei*, are occasionally presented in large quantity (*b*), which are isomorphous with those represented in fig. 161, *e*; and with respect to which, the same observations will apply. The large, flat, usually uni- or binucleated cells, exhibit a fatty degeneration of their contents, very

FIG. 162.

general and far advanced; and these correspond with the soft parts by which the water is rendered slightly milky (from minutely divided *olein* in suspension). We had an opportunity of observing this in an extensive cancer of the lower jaw and of the *cranium*. In cells of this kind, the *nuclei* may also be seen becoming larger and larger, and ultimately the vesicular spaces above noticed, filled with a hyaline or granular fluid ("reproductive spaces," Virchow), make their appearance. A morbid growth degenerated in this way is always accompanied with a more rapid destruction of the osseous substance; and ultimately very considerable portions of the bone may be removed, as in the medullary form.

It is manifest, more particularly in the epithelial form of cancer of the bones, that the intermediate family of *cancroid diseases*, proposed by several authors, stands in such intimate connexion with those growths whose organic development and retrogression characterize them as cancer, that the establishment of a distinct family, under the name of "cancroid," does not seem to us a scientific postulate.

The not unfrequent combination of the epithelial with the medullary form, also indicates an intimate relationship between the two.

§ 6. Lungs.

In these organs, cancer occurs in the form of nodules, projecting above the surface, or imbedded in the substance, of tolerable consistence, and affording on pressure a pultaceous turbid material. When the latter is treated with water, the suspended cells are rendered distinct, whose predominant form is sometimes the flattened or discoid, sometimes the fusiform; the *nuclei* are single, double, or multiple. The size of the cells not unfrequently varies in different nodules, but in most cases they are of a medium size. The fatty degeneration of the contents is especially manifest in the soft, pultaceous nodules; and in these, after the loosely adherent cells have been washed away with water, the fibrous bundles constituting the *cancer-stroma*, also infiltrated with fat, are readily brought into view. After treatment with the alkaline carbonates, numerous elastic filaments are rendered apparent, in which, in several of the cases examined, the characteristic arches of the pulmonary cells were

no longer recognizable; but it is, nevertheless, highly probable that the elastic element is not of new-formation, and has only been displaced from its natural position by the cancerous infiltration. But we have seen many instances in which characteristically convoluted pulmonary fibres together with the black lung-pigment lay in the midst of the cancerous growth. No doubt, therefore, can be entertained that the cancerous new-growth, like that of tubercle, occupies the air-cells.

In the case above noticed, of a woman having cancerous deposits in most of the organs, the lungs were studded with numerous nodules, from the size of a pin's head to that of a lentil, of a pale-yellow colour, tolerable consistence, and exhibiting, on section, an apparently homogeneous substance. To the naked eye, there was apparently no morphological character by which these growths could be distinguished from tubercle; and even microscopical examination afforded none of those elements which have been erroneously ascribed to cancer. In the molecular, flaky *matrix*, nothing could be seen but numerous *nuclei* (fig. 163, *a*), and flattened, subpolygonal cells (*b*), occasionally exhibiting a *nucleus* and some fatty molecules in their contents; corpuscles with an attenuated process (*b*+) were not unfrequently observed. The fatty degeneration of the cells had reached such an advanced stage, that ultimately they became transformed into an agglomeration of fatty molecules. The brownish-red pigmented cells (*d*) were probably derived from those in a state of fatty degeneration, by the reception of colouring matter.

Fig. 163.

It cannot be demonstrated that all these elementary organs were of new-formation, inasmuch as the mere *nuclei*, especially, might represent the remains of the *epithelium* of the pulmonary cells; but it is certain that the majority of these elements belonged to the cancer, since the latter formed nodules projecting considerably above the surface of the lung.

Another, far more important result, however, flows from the elementary constitution of these growths. If the numerous nodules disseminated throughout the lungs had been observed

by themselves alone, one might certainly have been puzzled to determine whether they should be arranged with the tuberculous or with the cancerous new-formations; but as they occurred in an individual who was almost universally affected with cancerous deposits, no hesitation could be felt in assigning them to the latter. It will be seen, therefore, that we have been guided in the designation of this morbid growth, not by its mere anatomical characters, whatever they might be, but by a comparison with other growths in the same organism. Such a variable nomenclature, however, is a sufficient proof that we are striving to set up strongly-defined boundaries where none exist in nature. Now, whether the nodule in question be regarded as *cancer* remaining at the stage of development commonly ascribed to tubercle, or as a tubercle developed simultaneously with cancerous formations in other organs, comes, pretty nearly, to the same thing.

It must be allowed that our ideas of *tubercle* and of *cancer* are not widely remote, but merely expressions (categories) indispensable in anatomical language, and requisite for the designation of particular modes of development of certain new-growths. The institution of categories of this kind proceeds from the methods pursued in human thought; at the same time it should not be forgotten that these indispensable categories have such numerous vacancies and deficiencies, that they can only be regarded as ideal, and not as things having an actual existence. Nature shows, that in one and the same individual a fibroid tumour may be formed in the *uterus*, and a medullary cancer in the liver: Where, then, is our supposed cancerous *dyscrasia?* It is well known that decided tuberculosis of the lungs, with cavities, &c., occurs together with cancer in other organs, with intermediate forms. Where, then, is the boundary between cancer and tubercle?

Cancer usually occurs as a secondary affection, in the lungs. On one occasion, Dr. Braun noticed some rounded nodules, as much as 0·39″ in diameter, in the lungs of a new-born child, rather towards the surface. On pressure, these nodules afforded a medullary juice, containing the various kinds of cells, mostly in a state of fatty degeneration, which are commonly met with in cancer. Besides this, a puriform *mucus* flowed from the divided *bronchi*. According to Dr. Braun,

there were no other cancerous deposits in
mother appeared healthy.

§ 7. LIVER.

The medullary form of *cancer*, which is
met with in this organ, has been subdivided
into the "crude" and the "true medullar
been shown by Rokitansky that these t
represent different degrees of development.
a well-marked encephaloid cancer-nodule in

FIG. 164.

jected above the surface of the liver, and wa
halves by a vertical section. The sharply d
sented a lobulated appearance, which was p
towards the surface of the liver; but the lo
is also shown in both surfaces of the sec
side may be observed a rather large cavit
depressions, into several *diverticula*, and h
nous lining. Blood-vessels ran in its soft,
the right half may also be seen some infun
sions, which, as well as the larger ones on
were filled with a greyish-red, creamy juice.
were very abundant, assembled in numerous
and bore some resemblance, as regards th
interrupted lines, to that of the vessels in

The hepatic substance in immediate contiguity with the cancerous growth was separated into a dark brown and dirty yellow. The hepatic cells, particularly those immediately around the morbid growth, contained pigment; in the yellow places, the cells were mostly in a state of fatty degeneration.

The parenchymatous cells of this cancer were for the most part fusiform, and in an advanced stage of fatty degeneration; by their fusion, and that of the areolar fibrous *stroma*, were formed *areolæ*, from whose walls (particularly of the larger ones) dendritic fibrous bundles depended, as was best seen when the parts were viewed under water, the bundles then floating out like minute *villi*. The blood was contained, partly, in vessels characterized by their simple structure, and partly had the appearance as if it were lodged in mere *areolæ*. The corpuscles were mostly of smaller size than usual, and the groups constituted of them manifestly corresponded with isolated new-formations of blood, as might be satisfactorily seen in the examination of the surface of sections of the several *lamellæ* of the cancerous nodule.

The cells which occasionally form the main constituent in well-marked encephaloid cancer are large and round, and enclose mostly large, elliptical *nuclei* with 2—3 *nucleoli*; the less abundant, fusiform cells with oblong *nuclei* are disposed in dendritic bundles. The cells frequently contain some fat and pigment-molecules; and fat and pigment may also be observed in large quantity in many parts of the cancer where the process of involution is further advanced; so abundantly, in fact, as, in these parts, to render the recognition of the fibrillar structure difficult. In these places, also, dirty red-brown masses (necrosed blood?) are very often met with, as well as *cholesterin*, and hyaline, concentric plates (colloid); and after treatment of the denser portions with the alkaline carbonates, a large quantity of convoluted, elastic filaments. From the rather more succulent portions of the cancer, moistened with water, a precipitate is obtained, by the use of acetic acid, consisting of straight filaments (mucin).

Now, when the *fibrous stroma* of a cancerous deposit of this kind is examined more closely,—which is to be done by taking a very thin lamella and waving it backwards and forwards briskly in water, by which means, especially at the edges,

the loosely adherent cells will be washed out of the *areolæ*—no undulating connective-tissue-bundles will be displayed, and only a streaky appearance, more resembling that of a closely plicated membrane, or of mucin-filaments in close apposition; occasionally, also, a network will be perceived, composed of short filaments, resembling those of coagulated fibrin. If a portion of this *stroma* be treated with acetic acid, either no increase whatever will be perceived in its transparency, or none approaching to that which might be expected to take place in connective tissue. Thus, we see a confirmation of the proposition before stated (p. 78), that a chiefly fibrous or mucoid framework may constitute the sole or the secondary *stroma*.

This fibrous framework is also formed without any previous cell-formation, simply from the precipitation of the protein-substance; for, in very minute cancerous nodules of the liver, treated with boiling water, or immersed in a weak solution of corrosive sublimate and dried, so as to be fitted to afford thin sections, a trabecular tissue is displayed, occasionally enclosing in its *areolæ*, no cells, but only a hyaline substance. These cribriform portions are immediately surrounded by the hepatic parenchyma and its vessels. When the sometimes round, oval, elongated, much sinuated, and occasionally angular vacuities are somewhat larger, they may be recognized even by the naked eye, and very well by the aid of a powerful lens, both by direct and by transmitted light. But in most cases, the trabecular tissue is so concealed by layers of cells, as not to be clearly seen, except in very thin parts of the sections, and after a careful, partial removal of the cells.

In close connexion (not as regards their *genesis*, but with respect to contiguity) with this fibrous framework are the fibre-cells with their oval or oblong *nuclei;* and these cells fall into a state of involution, together with the interstitial fibres, a large amount of fat and, occasionally, of pigment-molecules, being deposited in them. In consequence of which, the places in which they exist, even to the naked eye, exhibit a yellowish, reticular aspect; the network appearing opaque by transmitted light. Not long since, we had an opportunity of viewing a *reticulum* of this kind, displayed, in the most distinct manner, in some cancer-nodules of the liver.

If portions be taken from these nodules where the texture is more lax and to some extent granular, and little fragments be cut from these, either with the scalpel or with scissors, while floating under water, villous or papilliform processes arising from the *trabeculæ*, and filled with a molecular material, will not unfrequently be seen either solitary upon a long peduncle or, more rarely, in sessile groups. These distinctly circumscribed, sharply defined growths, described by Rokitansky as "hollow, clavate papillæ," must not be confounded with projecting, fibrous bundles torn across.

The more consistent nodules, affording on pressure only a trifling quantity of turbid juice, and presenting a deep-yellow, or red, speckled aspect, which have by many authors been described as crude forms of cancer, contain mostly small, often aborted cells; blood-vessels, in spite of the most careful search, cannot be found in them, the blood being collected in irregular *areolæ*. This new-formation of blood may take place to such an extent, that circumscribed spots, occasionally 0·39″ and more in diameter, formed of it, and appearing on section infiltrated with blood, are visible, projecting somewhat above the surface of the liver. These little tumours have been described by some as ecchymoses, and formerly, by Rokitansky, as cavernous swellings, but are, for the most part, referrible to cancer, since they contain, together with bulky blood-corpuscles, very numerous fatty granule-masses, oval or round *nuclei*, elliptical and fibre-cells, with one or several processes. The slender, elongated, fusiform cells alternate with long fibres presenting numerous varicosities. If the blood-corpuscles together with the cells be gently removed, and, besides, the still adherent parts be in a great measure washed away with a stream of water, the *stroma*, composed of a delicate, narrow-meshed, trabecular tissue is brought in view. This form of cancer, therefore, belongs to what has been described as "*blood-cancer*."

Medullary cancer of the liver, by the assumption of pigment, passes into *pigmented cancer* (*fungus melanodes*), acquiring a dirty grey, greyish-red, reddish-brown, or even black-brown colour. The usually elliptical or ellipsoidal cells attained, in one case of this kind, to a diameter of 0·047‴, whilst the smallest were scarcely so much as 0·0079‴ in size; the largest *nuclei* were 0·0123‴ in diameter, the average size being 0·0079‴;

outer table of the frontal bone, were parallel to each other, and extended to a distance of from 3·54—4·4‴ into the fungous growth, some slender, bony *lamellæ* penetrating still more deeply into it. On the anterior part of the right side of the *basis cranii*, a similar, jagged osseous mass, projected inwards towards the substance of the brain. The medullary morbid growth consisted, chiefly, of variously shaped *nuclei*, oval, biscuit-shaped, or of a trefoil form, which occasionally cohering together, constituted, as it were, an ill-defined, peripheral substance; they shrank a little under the action of acetic acid, but their original form was unaltered. These numerous, nuclear bodies, contained 1—2—3 prominent *nucleoli*, together with delicate granules, which did not convey the optical expression of fat-globules. Fully formed cells, with an investing membrane, were but rarely apparent. *Olein*, in a state of minute division, might also be seen in many of the fatty granule-masses. The osseous substance presented the same conditions as existed in the former case.

In the latter case, therefore, the new-growth seems to have been developed, as it were, in two directions. On the one hand, we see a gelatinous, and on the other a medullary form of cancer, attaining to a considerable bulk, whilst in both instances immature osseous-substance was developed from the bones. May not this twofold type of formation originate in the different kinds of vessels from which the growth receives its *blastema?* The vessels of the *periosteum* communicate, on the one side, with those of the lax investing connective tissue, and on the other, with those proceeding from the cortical substance of the bone; affording, in the latter case, the nutriment for the peripheral part of the bone, whilst in the former, they subserve the nutrition of the elementary organs of the connective tissue.

When the cancer is seated *in the substance of the bone*, its growth usually continues at the expense of the latter, and a rarefaction of the osseous tissue is the result. Or the parts of the bone enlarge, together with the cancerous substance, and become the osseous framework of the morbid growth. Among the different forms of cancer, as it occurs in bones—the gelatinous (areolar), medullary, fibrous, epithelial, and melanotic—the first and last, as is well known, are very rare. The *fibrous form* of *cancer* was apparent in several of the ribs of a woman

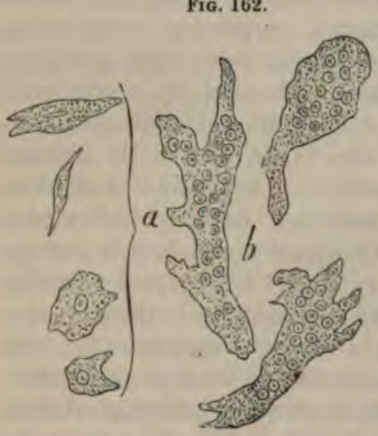
Of great interest, in many points of view, are the cancerous elements in the *portal blood*, which were first accurately described by Virchow. They occur, sometimes combined with cancer in other organs, sometimes in conjunction with hepatic cancer. In an instance communicated to us by Dr. Bamberger, the former was the case. The liver was considerably enlarged, of dense texture, and tuberous on the surface, each elevation being surrounded by a bloody *area* (probably blood extravasated from the portal veins around the groups of lobules). The parenchyma of the liver, of a grey and greenish-yellow colour, was in many places constituted of hepatic cells in a state of tolerable preservation, whilst in other parts the cells were far advanced in fatty degeneration, and had become disintegrated, nothing remaining but round *nuclei* and granule-masses. A serous fluid could be expressed from the substance of the tumours. Thin sections of the hepatic substance displayed only sanguineous spots, whose outlines were not very distinct, owing to the circumstance, that the infiltration of the parenchyma with fat had rendered it of a grey colour, and to some extent impervious to transmitted light. In the larger branches of the portal vein, the *lumen* was occupied by dirty-yellow, yellowish-red, and brownish plugs, readily divisible into smaller parcels, and in many places of softer consistence, which, on pressure, afforded a juice rendering the water turbid. Under water, nodular prominences and short processes might be perceived floating out, even by the naked eye. The elementary analysis showed the presence of cells, mostly of the sub-elliptical form, with an oval *nucleus* and distinct *nucleolus*; elongated cells were also met with, with one or both ends drawn out to a point. The elliptical cells were disposed in chains, and were also connected together by very delicate fibrinous filaments. When the substance was torn up, in addition to these, distinctly circumscribed corpuscles, some as much as 0·052''' in diameter, and having lateral protrusions, were liberated; these bodies bore some resemblance to rudimentary, papillary new-formations of connective tissue. This indubitable occurrence of the elements of cancer in the blood cannot, of course, be put to the credit of any theory respecting the propagation of *cancer* from one organ to another by hypothetical elements.[1]

[1] A very accurate description of the rare *gelatiniform cancer* in the liver, has

fat, and numerous fatty granule-masses. The neighbouring *medulla* is often of a deep red colour. It is well known that the affected bones, under these circumstances, lose some of their rigidity, and acquire a certain degree of flexibility. This is the case, in a more marked degree, when the medullary cancer appears, not as a circumscribed growth, but as a more or less dark-red, dirty, thin pultaceous substance replacing the marrow. In cancers of this kind, round elementary organs are chiefly met with (*vid.* fig. 112, *c*). The softened, flexible, osseous substance, when viewed in thin plates, no longer presents the normal structural condition; the intercorpuscular tissue assumes a broadly striped appearance, the *striæ* decussating in various directions; the bone-corpuscles appear at first as light spaces, and are ultimately wholly unrecognizable in the fissure-like vacuities. After the application of diluted hydrochloric acid, the striated texture of the softened bone is rendered far more distinct than it is in the normal condition.

The *epithelial form* is characterized, as in other tissues, by the granular texture; the individual granules of which it is composed may be the more readily expressed in proportion as the morbid growth is of softer consistence. The majority of the cells composing the growth are of the flattened kind, and in many places their forms have a surprising resemblance with those of the oral *epithelium* (fig. 162, *a*); but on the comparison of a considerable number, the jagged outlines above described will be remarked. Moreover, in cancerous growths, of this kind, large, flattened corpuscles with jagged processes and numerous *nuclei*, are occasionally presented in large quantity (*b*), which are isomorphous with those represented in fig. 161, *e*; and with respect to which, the same observations will apply. The large, flat, usually uni- or binucleated cells, exhibit a fatty degeneration of their contents, very

Fig. 162.



pigeon's egg; one, of the latter dimensions, completely filled with a new-formed substance, was seated on the convex border of the gland. The consistence of this substance appeared softer than that of the kidney; it was of a dirty yellowish-red colour, and afforded on pressure a tolerably abundant turbid juice. With the assistance of a lens, brownish-yellow vegetations could be readily extracted from it, which occasionally assumed the figure and size of the intestinal *villi*, had lateral prolongations, and were surrounded by numerous, convoluted blood-vessels. The elements to which the turbidity of the juice was due were flattened, polygonal, mostly brownish cells, with an oval, excentric *nucleus*, and were thus distinguished from hepatic cells in a state of fatty degeneration, to which they bore the closest resemblance in outward form and in size. These cells also occurred in groups of 8—10 or more, imbedded in a hyaline, depressed, discoid matrix-substance, and formed the main constituent of globular, conical, villous growths, of very soft consistence, and which became disintegrated under the prolonged action of water. In addition to the above, there were also noticed elongated, saccular organs, in diameter about equal to the middle sized *tubuli uriniferi*, convoluted, and containing granule-masses, here and there, in the interior. Oval and ellipsoidal *nuclei* lay at regular distances apart in their transparent wall, and by these the new-formed *sacculi* were distinguished from the *tubuli uriniferi*, whose *membrana propria*, as is well known, contains no *nuclei*. The *sacculi* were occasionally dilated into cæcal, closed spaces, whose outer wall was formed by a wavy fibrillar structure. Fusiform cells, crossing each other in various directions, were apparently lodged in the wall of the *sacculus*. Since the walls of the blood-vessels and their cæcal terminations exhibited essentially the same structure, and were, consequently, distinguished only by their organic contents—the white and red blood-corpuscles—it is clear that they were not developed from the hyaline *blastema* until the latter had become enclosed in independent walls.

§ 9. Lymphatic glands.

The usual forms of cancer seen in these organs are the medullary and fibrous, and, not unfrequently also, aggregations

no longer recognizable; but it is, nevertheless, highly probable that the elastic element is not of new-formation, and has only been displaced from its natural position by the cancerous infiltration. But we have seen many instances in which characteristically convoluted pulmonary fibres together with the black lung-pigment lay in the midst of the cancerous growth. No doubt, therefore, can be entertained that the cancerous new-growth, like that of tubercle, occupies the air-cells.

In the case above noticed, of a woman having cancerous deposits in most of the organs, the lungs were studded with numerous nodules, from the size of a pin's head to that of a lentil, of a pale-yellow colour, tolerable consistence, and exhibiting, on section, an apparently homogeneous substance. To the naked eye, there was apparently no morphological character by which these growths could be distinguished from tubercle; and even microscopical examination afforded none of those elements which have been erroneously ascribed to cancer. In the molecular, flaky *matrix*, nothing could be seen but numerous *nuclei* (fig. 163, *a*), and flattened, subpolygonal cells (*b*), occasionally exhibiting a *nucleus* and some fatty molecules in their contents; corpuscles with an attenuated process (*b*+) were not unfrequently observed. The fatty degeneration of the cells had reached such an advanced stage, that ultimately they became transformed into an agglomeration of fatty molecules. The brownish-red pigmented cells (*d*) were probably derived from those in a state of fatty degeneration, by the reception of colouring matter.

FIG. 163.

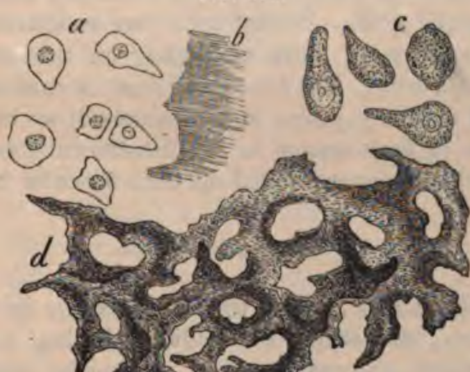
It cannot be demonstrated that all these elementary organs were of new-formation, inasmuch as the mere *nuclei*, especially, might represent the remains of the *epithelium* of the pulmonary cells; but it is certain that the majority of these elements belonged to the cancer, since the latter formed nodules projecting considerably above the surface of the lung.

Another, far more important result, however, flows from the elementary constitution of these growths. If the numerous nodules disseminated throughout the lungs had been observed

§ 10. Retroperitoneal cancer.

Lobstein, as is well known, assigns the name of retroperitoneal growths to those tumours which always commence behind that portion of the *peritoneum* which lines the posterior walls of the abdomen. He expresses the opinion that they commence on the vertebral column, but this notion cannot be regarded as holding good in all cases. A cancerous tumour, as large as a child's head, situated beneath the stomach, and for the most part of a soft medullary consistence, extended, it is true, as far as the *vertebræ*, but the bones were not implicated. The tumour consisted of several nodular lobes, several of which, of firmer consistence, presented a *cartilaginous*, cortical portion, and a central substance of a structure resembling that of a *spongy bone*. The cartilage-cells, towards the ossified portion, were rounded, elongated, triangular, quadrangular, &c., contained a granular rounded *nucleus*, and were either isolated or assembled in groups of two, three, or several together (fig. 165, *a*); the intercellular substance was in parts clear and

Fig. 165.



structureless, and, in parts, presented a striated texture (*b*). Towards the surface, the cartilage-cells, which were loosely imbedded in the interstitial substance, and had consequently here and there fallen out, were filled with fine-molecular contents (*c*), and the *nucleus*, which was of considerable size, was some-

there were no other cancerous deposits in the body. The mother appeared healthy.

§ 7. Liver.

The medullary form of *cancer*, which is that most usually met with in this organ, has been subdivided by several writers into the "crude" and the "true medullary." But it has been shown by Rokitansky that these two forms merely represent different degrees of development. We have figured a well-marked encephaloid cancer-nodule in fig. 164. It pro-

Fig. 164.

jected above the surface of the liver, and was divided into two halves by a vertical section. The sharply defined outline presented a lobulated appearance, which was particularly evident towards the surface of the liver; but the lobular conformation is also shown in both surfaces of the section. On the left side may be observed a rather large cavity, subdivided, by depressions, into several *diverticula*, and having no membranous lining. Blood-vessels ran in its soft, uneven wall. In the right half may also be seen some infundibuliform depressions, which, as well as the larger ones on the opposite side, were filled with a greyish-red, creamy juice. The blood-vessels were very abundant, assembled in numerous insulated groups, and bore some resemblance, as regards their course in wavy, interrupted lines, to that of the vessels in connective tissue.

occasionally be distinctly raised. This peripheral layer of blood-vessels is subservient, without doubt, to the nutrition and development of the cancerous growth. The fatty tissue, usually surrounding the morbid growth, is in parts very vascular, and presents a deeper yellow colour than elsewhere. In a section, the colour of the lobules presents remarkable diversities; for whilst in the one part they appear of a rose-red hue, in another this passes into a greyish-red, yellowish-grey, and brownish-yellow tint. The portions marked with red spots, or pervaded by distinct blood-vessels, are usually situated at the points of radiation of, and in the interstices between, the lobules. The consistence of an entire group of the latter may be so soft, and their connexion so lax, that they break up into a pultaceous substance, conveying an apparent fluctuation to the feel, which has occasionally given rise, in the diagnosis of such tumours in the living subject, to the confounding of them with *cystosarcoma;* whilst the consistence of other groups of lobules is so much increased, as to equal the density ascribed to *scirrhus;* these portions of the cancerous growth, together with those evolved in another direction, are in a state of involution.

The material composed of cells, which may be expressed in the form of pultaceous, friable masses, presents the utmost diversity in the shape of its elements. These are rounded, oval, uni-, bi-, and multipolar cells, whose excentric, oval *nucleus* often encloses 2—3 *nucleoli* (fig. 166, *a*). The processes of these cells frequently expand in a penicillar manner, exhibiting varicose enlargements, and bifurcations. The multinuclear cells (*B*) are broader and misshapen; the *nuclei,* which either remain in connexion, or are separated by an intervening portion of contents, differ considerably in size, and often collect towards one side of the cell. As the latter increases in volume, a globular body becomes apparent in the interior, enclosing a mass of agglomerated granules (*b b*). With respect to an appearance of this kind, it has already been said that we regard this body as a vesicular *nucleus,* since the stages of its evolution, up to a certain size, may be followed. In Virchow's opinion it would be a "reproductive space" (Brutraum), and the central corpuscle would not be analogous to the *nucleolus.* For the reasons above stated, however, we are compelled to regard it as such, and are able also to observe the stages of transition

the loosely adherent cells will be washed out of the *areolæ*—no undulating connective-tissue-bundles will be displayed, and only a streaky appearance, more resembling that of a closely plicated membrane, or of mucin-filaments in close apposition; occasionally, also, a network will be perceived, composed of short filaments, resembling those of coagulated fibrin. If a portion of this *stroma* be treated with acetic acid, either no increase whatever will be perceived in its transparency, or none approaching to that which might be expected to take place in connective tissue. Thus, we see a confirmation of the proposition before stated (p. 78), that a chiefly fibrous or mucoid framework may constitute the sole or the secondary *stroma*.

This fibrous framework is also formed without any previous cell-formation, simply from the precipitation of the protein-substance; for, in very minute cancerous nodules of the liver, treated with boiling water, or immersed in a weak solution of corrosive sublimate and dried, so as to be fitted to afford thin sections, a trabecular tissue is displayed, occasionally enclosing in its *areolæ*, no cells, but only a hyaline substance. These cribriform portions are immediately surrounded by the hepatic parenchyma and its vessels. When the sometimes round, oval, elongated, much sinuated, and occasionally angular vacuities are somewhat larger, they may be recognized even by the naked eye, and very well by the aid of a powerful lens, both by direct and by transmitted light. But in most cases, the trabecular tissue is so concealed by layers of cells, as not to be clearly seen, except in very thin parts of the sections, and after a careful, partial removal of the cells.

In close connexion (not as regards their *genesis*, but with respect to contiguity) with this fibrous framework are the fibre-cells with their oval or oblong *nuclei;* and these cells fall into a state of involution, together with the interstitial fibres, a large amount of fat and, occasionally, of pigment-molecules, being deposited in them. In consequence of which, the places in which they exist, even to the naked eye, exhibit a yellowish, reticular aspect; the network appearing opaque by transmitted light. Not long since, we had an opportunity of viewing a *reticulum* of this kind, displayed, in the most distinct manner, in some cancer-nodules of the liver.

If portions be taken from these nodules where the texture is more lax and to some extent granular, and little fragments be cut from these, either with the scalpel or with scissors, while floating under water, villous or papilliform processes arising from the *trabeculæ*, and filled with a molecular material, will not unfrequently be seen either solitary upon a long peduncle or, more rarely, in sessile groups. These distinctly circumscribed, sharply defined growths, described by Rokitansky as "hollow, clavate papillæ," must not be confounded with projecting, fibrous bundles torn across.

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the least occurred in the smallest cells, their size being but little below that of the latter. The largest *nucleoli* presented a diameter of 0·00158‴, the small, one of 0·00079‴, the smallest being even less than that. There were not unfrequently 2—8 *nuclei* in a single cell; and parent-cells also occurred with distinctly apparent walls to the secondary cells. The cell-contents were frequently in a state of advanced fatty degeneration; large, red-brown pigment-molecules were present in comparatively few cells; they occurred in far greater number free, among the cells and fibres. Rokitansky has also noticed in a *fungus* of this kind, and particularly in the fluctuating, soft *tubera*, very loosely connected, villus-like structures, appearing to the naked eye as white, fibrillar tracts with extremely numerous blood-vessels running in the same direction as the fibres. On closer examination, he found in these fibrillar tracts, long, hyaline bands, composed of wavy, contorted, connective-tissue-fibrils, with numerous, but only simple or clavate protrusions.

Cystic cancer of the liver, or, in other words, a medullary form with well formed cysts, once came under our observation, in an old Bear. One of the larger cysts, which projected above the surface of the liver, partly out of the cancerous mass, was about 0·78″ in diameter. Its contents were a thin fluid, and slightly turbid from the presence of fatty granule-masses and suspended fat-globules, whilst its inner surface was lined with flattened, various-sized cells, containing a parietal, oblong *nucleus*; its outer investment was constituted of fibrous connective tissue, with orange-coloured pigment-granules imbedded in it. The cancerous mass was tolerably consistent, containing abundance of blood and fat, with cells, of only small size, in a far advanced state of fatty degeneration. The dense trabecular tissue, after treatment with the alkaline carbonates, exhibited numerous, elastic, fibrous networks. The *parenchyma* of the liver was very fatty. In the blood of the portal vein, down to its fine ramifications having a capillary structure, were found numerous deposits of isolated, brownish-black, and perfectly opaque granules, which disappeared, in part, under the agency of the alkaline carbonates. They had manifestly been formed from the *hæmatin* of the necrosed portal blood. We are satisfied, also, that in Man, in cases of cancer of the liver, a considerable quantity of *hæmatin* is precipitated in the blood of the portal vein.

Of great interest, in many points of view, are the cancerous elements in the *portal blood*, which were first accurately described by Virchow. They occur, sometimes combined with cancer in other organs, sometimes in conjunction with hepatic cancer. In an instance communicated to us by Dr. Bamberger, the former was the case. The liver was considerably enlarged, of dense texture, and tuberous on the surface, each elevation being surrounded by a bloody *area* (probably blood extravasated from the portal veins around the groups of lobules). The parenchyma of the liver, of a grey and greenish-yellow colour, was in many places constituted of hepatic cells in a state of tolerable preservation, whilst in other parts the cells were far advanced in fatty degeneration, and had become disintegrated, nothing remaining but round *nuclei* and granule-masses. A serous fluid could be expressed from the substance of the tumours. Thin sections of the hepatic substance displayed only sanguineous spots, whose outlines were not very distinct, owing to the circumstance, that the infiltration of the parenchyma with fat had rendered it of a grey colour, and to some extent impervious to transmitted light. In the larger branches of the portal vein, the *lumen* was occupied by dirty-yellow, yellowish-red, and brownish plugs, readily divisible into smaller parcels, and in many places of softer consistence, which, on pressure, afforded a juice rendering the water turbid. Under water, nodular prominences and short processes might be perceived floating out, even by the naked eye. The elementary analysis showed the presence of cells, mostly of the sub-elliptical form, with an oval *nucleus* and distinct *nucleolus*; elongated cells were also met with, with one or both ends drawn out to a point. The elliptical cells were disposed in chains, and were also connected together by very delicate fibrinous filaments. When the substance was torn up, in addition to these, distinctly circumscribed corpuscles, some as much as 0·052‴ in diameter, and having lateral protrusions, were liberated; these bodies bore some resemblance to rudimentary, papillary new-formations of connective tissue. This indubitable occurrence of the elements of cancer in the blood cannot, of course, be put to the credit of any theory respecting the propagation of *cancer* from one organ to another by hypothetical elements.[1]

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§ 8. Kidney.

The cancer-nodules, sometimes enclosed by the renal substance as in a sort of capsule, sometimes coalescent with it at their periphery, are either of firm consistence and of a dirty yellow colour, often spotted with red,—when they correspond with the crude cancer of Virchow,—or softer, and afford on pressure a considerable quantity of a milky juice. The more consistent nodules, not unfrequently connected with Bright's disease, occasionally exhibit, notwithstanding they may have attained to a considerable bulk, an apparently homogeneous structure without a trace of vascularity. The cells existing in this kind of nodule are small, comparatively scanty, and the fibrous framework very close. The new-formed red blood-corpuscles are enclosed in *areolæ* without independent walls, and constitute, when present in large number together, the sanguineous spots.

In a considerable number of nodules, some are usually of softer consistence, and these are pervaded by blood-red, often blackish points, about the size of a pin's head. In one case of this kind, in which cancerous deposits occurred in several organs, we found, for the most part, flattened cells in an advanced stage of fatty degeneration, so closely resembling the epithelial cells of the *tubuli uriniferi*, that in that respect it could not be determined whether they represented the remains of the renal *parenchyma* or were of new-formation. In other places, again, fibre-cells appeared to be the main constituent. The reddish-brown and black pigment was deposited in isolated groups in the morbid growth.

A new-formation observed in the cortical substance of the kidneys of an old, dropsical woman, we think, should be described as approaching nearest to villous cancer. In the situation in question, there were several cysts, some as big as a

been given by Luschka, who is also satisfied that the walls of the *alveoli* (by us always termed *areolæ*), are not by any means independent, isolated membranes, but an integral constituent of a lamellar framework, composed of a corresponding fibrous tissue. The inner surface of the large *areolæ*, he noticed, to be invested with a frequently very distinct *epithelium*. He also supposes that the straight, not undulating, fibres, arise immediately out of the *blastema*.

pigeon's egg; one, of the latter dimensions, completely filled with a new-formed substance, was seated on the convex border of the gland. The consistence of this substance appeared softer than that of the kidney; it was of a dirty yellowish-red colour, and afforded on pressure a tolerably abundant turbid juice. With the assistance of a lens, brownish-yellow vegetations could be readily extracted from it, which occasionally assumed the figure and size of the intestinal *villi*, had lateral prolongations, and were surrounded by numerous, convoluted blood-vessels. The elements to which the turbidity of the juice was due were flattened, polygonal, mostly brownish cells, with an oval, excentric *nucleus*, and were thus distinguished from hepatic cells in a state of fatty degeneration, to which they bore the closest resemblance in outward form and in size. These cells also occurred in groups of 8—10 or more, imbedded in a hyaline, depressed, discoid matrix-substance, and formed the main constituent of globular, conical, villous growths, of very soft consistence, and which became disintegrated under the prolonged action of water. In addition to the above, there were also noticed elongated, saccular organs, in diameter about equal to the middle sized *tubuli uriniferi*, convoluted, and containing granule-masses, here and there, in the interior. Oval and ellipsoidal *nuclei* lay at regular distances apart in their transparent wall, and by these the new-formed *sacculi* were distinguished from the *tubuli uriniferi*, whose *membrana propria*, as is well known, contains no *nuclei*. The *sacculi* were occasionally dilated into cæcal, closed spaces, whose outer wall was formed by a wavy fibrillar structure. Fusiform cells, crossing each other in various directions, were apparently lodged in the wall of the *sacculus*. Since the walls of the blood-vessels and their cæcal terminations exhibited essentially the same structure, and were, consequently, distinguished only by their organic contents—the white and red blood-corpuscles—it is clear that they were not developed from the hyaline *blastema* until the latter had become enclosed in independent walls.

§ 9. Lymphatic glands.

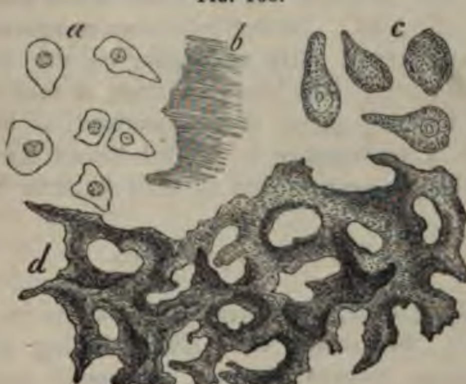
The usual forms of cancer seen in these organs are the medullary and fibrous, and, not unfrequently also, aggregations

of black granular pigment may be observed. We noticed a well-marked instance of *villous cancer* in a bronchial gland of an individual affected with cancerous deposits in several organs. The swollen gland, when incised and compressed, afforded an abundance of milky, turbid fluid, after the washing away of which, a fine network, composed of very delicate grey *trabeculæ*, came into view. Portions cut off with the scissors, and drawn several times through clear water, displayed these *trabeculæ*, floated out, and gradually sub-dividing into finer and finer branches. If these were so displayed that but few layers were superimposed upon each other, the mode of division could be accurately traced with a magnifying power of 60—90 diam. The thicker *trabeculæ*, some of which even exceeded 0·088‴ in diameter, became gradually so much attenuated by their arborescent branching, as to be reduced below 0·0066—0·0044‴. As regards their structure, considerable diversity was apparent; some consisting of connective-tissue-bundles, running in the direction of their longitudinal axis, whilst in others oblong *nuclei* were perceptible, disposed at regular distances apart. Many of these *trabeculæ* appeared to enclose a canal, and thus to be hollow; occasionally, also, parts of them were infiltrated with fat- and pigment-molecules, and, consequently, were in a state of retrograde metamorphosis. Numerous papillary excrescences, usually standing in groups, were seated on the middle-sized *trabeculæ*; and on many of the thinner *trabeculæ* divided into short internodes, these pedicellate papillary groups resembled the ultimate vesicles of an acinose gland. The indented border of the hemispherical papillary growths was sharply defined, and in many instances they seemed to contain a hyaline *blastema*. The substance, composed, for the most part, of imperfectly developed cells, which constituted the milky, expressed juice, was lodged in the interstices of this trabecular system and its cæcal prolongations. It was, in fact, composed principally of rounded, grey *nuclei*, about 0·0031—0·0044‴ in diameter, surrounded by a narrow indistinctly defined border indicating the cell-contents; a perfect membrane existed in comparatively but few of them.

§ 10. Retroperitoneal cancer.

Lobstein, as is well known, assigns the name of retroperitoneal growths to those tumours which always commence behind that portion of the *peritoneum* which lines the posterior walls of the abdomen. He expresses the opinion that they commence on the vertebral column, but this notion cannot be regarded as holding good in all cases. A cancerous tumour, as large as a child's head, situated beneath the stomach, and for the most part of a soft medullary consistence, extended, it is true, as far as the *vertebræ*, but the bones were not implicated. The tumour consisted of several nodular lobes, several of which, of firmer consistence, presented a *cartilaginous*, cortical portion, and a central substance of a structure resembling that of a *spongy bone.* The cartilage-cells, towards the ossified portion, were rounded, elongated, triangular, quadrangular, &c., contained a granular rounded *nucleus*, and were either isolated or assembled in groups of two, three, or several together (fig. 165, *a*); the intercellular substance was in parts clear and

Fig. 165.



structureless, and, in parts, presented a striated texture (*b*). Towards the surface, the cartilage-cells, which were loosely imbedded in the interstitial substance, and had consequently here and there fallen out, were filled with fine-molecular contents (*c*), and the *nucleus*, which was of considerable size, was some-

times concealed, sometimes appeared to be altogether wanting; the *nucleolus* had the aspect of a sharply-defined, comparatively large granule. The ossified portion, which was of a well-marked areolar type (*d*), could not be distinctly viewed until the softer tissues adherent to it were washed away. The spaces, of various dimensions, existing in the osseous frame-work were sub-divided into several loculaments by short, pointed or truncated, projecting processes. The longer, pointed or rounded papillary processes sprung from the anastomosing ossified *trabeculæ*, and corresponded in all respects with the analogous productions of the soft cancerous *stroma*; occasionally, also, fibrous bands proceeded from them, which united with corresponding bands from other ossified processes, so as to form bridges. In this way the soft cancerous framework was immediately continuous with that which was ossified.

The soft cancerous matter contained principally a mere nuclear substance; the *nuclei* were sometimes small and round, and resembled, also, in the bulky accumulations formed by them those met with in the *thymus*, lymphatic glands, &c.; whilst in other places, from their great dimensions, and the large size of the round or elongated *nucleolus*, they might be confounded with cells. But that this was not their nature was shown by the use of acetic acid. Perfect cells were comparatively rare, whilst aggregations of fatty molecules, on the other hand, occurred abundantly. The blood was free, or enclosed in wide vessels; and in many places it was necrosed, as indicated by the existence of dark-orange or reddish-brown masses of corpuscles, which no longer yielded up their *hæmatin* to water.

§ 11. Mammary gland.

The *medullary form*, which frequently occurs in this situation, assumes the shape of nodules having a lobulated structure, whose external surface is usually spotted with red, so as to lead to the supposition of the existence of minute extravasations of blood; but this is not the case. These spots correspond, far more probably, with collections of new-formed blood, which may also be observed enclosed in independent walls: in fact, the blood-vessels are developed in proportion to the thickness of the investing layer of connective-tissue, which may

occasionally be distinctly raised. This peripheral layer of blood-vessels is subservient, without doubt, to the nutrition and development of the cancerous growth. The fatty tissue, usually surrounding the morbid growth, is in parts very vascular, and presents a deeper yellow colour than elsewhere. In a section, the colour of the lobules presents remarkable diversities; for whilst in the one part they appear of a rose-red hue, in another this passes into a greyish-red, yellowish-grey, and brownish-yellow tint. The portions marked with red spots, or pervaded by distinct blood-vessels, are usually situated at the points of radiation of, and in the interstices between, the lobules. The consistence of an entire group of the latter may be so soft, and their connexion so lax, that they break up into a pultaceous substance, conveying an apparent fluctuation to the feel, which has occasionally given rise, in the diagnosis of such tumours in the living subject, to the confounding of them with *cystosarcoma;* whilst the consistence of other groups of lobules is so much increased, as to equal the density ascribed to *scirrhus;* these portions of the cancerous growth, together with those evolved in another direction, are in a state of involution.

The material composed of cells, which may be expressed in the form of pultaceous, friable masses, presents the utmost diversity in the shape of its elements. These are rounded, oval, uni-, bi-, and multipolar cells, whose excentric, oval *nucleus* often encloses 2—3 *nucleoli* (fig. 166, *a*). The processes of these cells frequently expand in a penicillar manner, exhibiting varicose enlargements, and bifurcations. The multinuclear cells (*B*) are broader and misshapen; the *nuclei,* which either remain in connexion, or are separated by an intervening portion of contents, differ considerably in size, and often collect towards one side of the cell. As the latter increases in volume, a globular body becomes apparent in the interior, enclosing a mass of agglomerated granules (*b b*). With respect to an appearance of this kind, it has already been said that we regard this body as a vesicular *nucleus,* since the stages of its evolution, up to a certain size, may be followed. In Virchow's opinion it would be a "reproductive space" (Brutraum), and the central corpuscle would not be analogous to the *nucleolus.* For the reasons above stated, however, we are compelled to regard it as such, and are able also to observe the stages of transition

the loosely adherent cells will be washed out of the *areolæ*—no undulating connective-tissue-bundles will be displayed, and only a streaky appearance, more resembling that of a closely plicated membrane, or of mucin-filaments in close apposition; occasionally, also, a network will be perceived, composed of short filaments, resembling those of coagulated fibrin. If a portion of this *stroma* be treated with acetic acid, either no increase whatever will be perceived in its transparency, or none approaching to that which might be expected to take place in connective tissue. Thus, we see a confirmation of the proposition before stated (p. 78), that a chiefly fibrous or mucoid framework may constitute the sole or the secondary *stroma*.

This fibrous framework is also formed without any previous cell-formation, simply from the precipitation of the protein-substance; for, in very minute cancerous nodules of the liver, treated with boiling water, or immersed in a weak solution of corrosive sublimate and dried, so as to be fitted to afford thin sections, a trabecular tissue is displayed, occasionally enclosing in its *areolæ*, no cells, but only a hyaline substance. These cribriform portions are immediately surrounded by the hepatic parenchyma and its vessels. When the sometimes round, oval, elongated, much sinuated, and occasionally angular vacuities are somewhat larger, they may be recognized even by the naked eye, and very well by the aid of a powerful lens, both by direct and by transmitted light. But in most cases, the trabecular tissue is so concealed by layers of cells, as not to be clearly seen, except in very thin parts of the sections, and after a careful, partial removal of the cells.

In close connexion (not as regards their *genesis*, but with respect to contiguity) with this fibrous framework are the fibre-cells with their oval or oblong *nuclei*; and these cells fall into a state of involution, together with the interstitial fibres, a large amount of fat and, occasionally, of pigment-molecules, being deposited in them. In consequence of which, the places in which they exist, even to the naked eye, exhibit a yellowish, reticular aspect; the network appearing opaque by transmitted light. Not long since, we had an opportunity of viewing a *reticulum* of this kind, displayed, in the most distinct manner, in some cancer-nodules of the liver.

to the circumstance that, at this time, no cell-membrane is formed. After perforating the skin, the cancerous mass continues to grow; and towards its surface may be observed numerous bloody points, which, in vertical sections, are seen to constitute a border or seam of the same colour, below the level of the outer surface, and exhibit no trace of any vascular ramification. This new-formed blood is analogous to that which is observed in the so-termed "fleshy warts" in *cicatrices* in process of formation. The puriform and sanious matter on the surface of the ulcer contains no pus-corpuscles, but simply the disintegrated cancerous parenchyma.

The *areolæ* of the medullary cancer become enlarged by the partial fusion of the more delicate *trabeculæ* of the *stroma*, and are thus transformed into *cystic cavities*, filled with a thick, milky fluid containing abundance of minutely divided fat, granule-masses, and cells in a state of fatty degeneration. In this way is produced the form of *cancer* termed *cystocarcinoma*. We have not hitherto met with an instance, in which the inner surface of these cysts was smooth and covered with an *epithelium*; instead of which, it appears to be invested with a delicate villosity constituted of groups of cells. Occasionally, also, a delicate, dendritic, trabecular tissue, with cells adherent upon it, projects into the cavity.

In *fibrous cancer*, only a trifling quantity of turbid juice can be expressed, the consistence is tolerably firm, and frequently, also, grey streaks may be observed, here and there assuming a greyish-yellow colour, and uniting, so as to form a network. In this way is produced the form termed "reticular cancer" by Joh. Müller. The blood-vessels are scanty. Fibre-cells, as is well known, constitute the main element of the growth; but groups of rounded cells are also presented, furnished with one or several, large, oval *nuclei* containing 1—3 prominent *nucleoli*, and which may also be seen, collected into large masses by themselves. The portions where this is the case, in fibrous cancer, are of less consistence, and approach more nearly to the character of the medullary form. In other portions of the same growth the *nuclei* are very often of far smaller dimensions, corresponding to other stages of development.

The *reticulum*, as before stated, is constituted of strong fibrous bundles, infiltrated with fatty matter in a state of

minute division; but tracts may also be observed which, when cut across, are seen, even by the naked eye, to enclose a canal, and which are, therefore, hollow. These may be either arterial vessels in a state of involution, or may represent the hollow *trabeculæ* of the cancerous *stroma* pointed out by Rokitansky. Fat-cells occur not unfrequently, imbedded in the morbid growth, either isolated or assembled into considerable groups. Elastic tissue exists in parts in very large quantity.

The subcutaneous vessels of the corresponding part of the skin are enlarged as the growth rises, present varicose dilatations, and, by degrees, the affected integument becomes involved in the cancerous infiltration. In parts, also, the skin may be observed, apparently infiltrated with *pus*, but it contains simply an innumerable multitude of granule-masses of the most various dimensions, with an abundance of isolated fat-globules. This is succeeded by the destruction of the skin involved in the morbid growth, and the formation of an ulcer, at whose base and borders the cancerous new-formation with a medullary character is developed, in some places, whilst in others the involution of the new-formation results in cicatriform contractions.

We have only once had an opportunity of examining the rarer form of *gelatinous cancer*. The tumour had been removed some years before from the breast of a woman, together with a portion of the superjacent skin, and the specimen had been preserved in alcohol. Its size might have equalled that of a large walnut, and it was circumscribed by a distinct envelope of connective tissue. Even with the naked eye, a delicate areolar texture might be distinguished on the surface of a section, the *areolæ* in which, were filled with yellow, transparent, gelatinous masses, besides which white points and streaks were observable. In longer sections, which were readily made with the scalpel, a fibrous tunic could be perceived at the borders of the growth (fig. 167, *a*), from which an areolated fibrous tissue penetrated through all parts of the parenchyma of the tumour. In the constitution of this framework the larger fibrous bundles (*c c*) gave off arching,

Fig. 167.

arborescent branches, which united with others coming from different sides. In the interior of these *areolæ*, brownish-yellow agglomerations were visible (*b*), whose form and connexions could not be accurately ascertained with a less magnifying power than one of 100 diameters. The outlines of these brownish-yellow corpuscles were characterized by their multifariousness; they were round, indented in various ways, club-shaped, furnished with lateral, verrucose elevations, &c., and frequently presented well-defined vacuities. These bodies, moreover, could be traced to their point of origin,—viz., the fibrous *stroma*, upon which they were seated, sometimes as short and small, sometimes as elongated outgrowths.

With higher magnifying powers, *nuclear* bodies might, in many places, be clearly distinguished in the brownish-yellow masses; no doubt, consequently, could be entertained as to their representing an agglomeration of cells. The fibrillation was usually of the straight, rigid kind (like that of mucin-filaments); wavy connective-tissue-bundles were rarer. The oblong corpuscles imbedded in the gelatinous substance, prolonged on each side into a fine point, lying in parallel directions, and at pretty uniform distances apart, should not, we think, be described as *nuclei*, regarding them rather as the rudiments of the coagulating mucin. They were also morphologically distinct from the *nuclei* of the fibre-cells, observable in many places.

Rokitansky has described a precisely analogous case, and expresses the opinion that the rounded openings in the club-shaped excrescences, arise from absorption; but the explanation would seem to be more obvious that these excrescences, by their extension, and their throwing out of lateral processes which again unite with the stem, embrace the pre-existing *trabeculæ*, and, consequently, that a hole must exist where the latter pass through.

These various forms of cancer occur in combination, some portions of a tumour presenting a well-marked *medullary* character, others that of a *fibrous* cancer, whilst smaller portions, at the periphery, exhibit a *gelatiniform* condition.

§ 12. Uterus.

Medullary cancer is frequently found in this situation, in the dead subject, in a state of sanious decomposition. The connective-tissue-fibres, which are more slowly disintegrated, constitute the main part of the fringe-like, dependent portions. In many places groups of *nuclei* may still be recognized in the organic *detritus*. The dirty, brownish-red colour of the putrefied tissue is due to decomposed blood. The cells of every variety of form are not distinctly apparent, except in those parts of the new-formation which are more deeply seated, and by which the tissue of the vaginal portion of the organ is infiltrated. The consistence of the infiltrated tissue is greater in proportion to the paucity of these cells and the smallness of their size; but when more numerous and individually larger, the corresponding part of the *uterus* enlarges, owing to the opening up, as it were, of the fibrous tissue of which it is constituted. The new-formed blood-vessels, in morbid growths of this kind, are not, unfrequently, of considerable volume, and, in consequence of the decomposition advancing from below upwards, give rise to hemorrhages.

Occasionally the *cancer* grows on the lips of the *uterus*, and assumes more or less of a *cauliflower* appearance. This form, which has been described under various names, such as "cauliflower excrescence" by Clarke, "cancroid" by Virchow, and by Rokitansky as "epidermic cancer," and as analogous to villous cancer, has been once submitted to our observation. The tumour was flattened, oval, about half an inch in diameter, and had a cauliflower aspect, exactly like the analogous *condylomata*. In the recent state it possessed a bluish-red colour, and was divided by deepish indentations into lobes, which were again subdivided by shallower grooves into lobules, from which club-shaped prominences arose. After the growth had lain for a short time in very dilute sulphuric acid (10—15 drops of acid to an ounce of water), the rusty-coloured ramifications, with their irregular offsets, could be recognized by the naked eye. Their colour was of course due to the action of the acid upon the *hæmatin*. When more closely examined, the much convoluted course of the vessels, the coils formed by them and their volu-

minous terminal loops, could be readily traced. The transverse area of one of the vessels, constituting the loop at the apex of a *papilla*, amounted to four or five times that of the normal loops in the *papillæ* of the lips of the *uterus*. Not unfrequently one branch of the loop was concealed by the other, so that the appearance was presented of a reddish-brown, sacciform protrusion of the vessel. The dilute sulphuric acid, moreover, coloured the tissue, constituting the proper *stroma*, of a yellowish hue, whilst the epithelial layer remained white. Owing to this, the surface of a section exhibited, very beautifully, even to the naked eye, the appearance of branches springing from a base of connective tissue, and splitting into twigs which, towards the surface, were covered with a thick layer of *epithelium*. The connective-tissue-stroma was more or less lax in its texture, and the *papillæ* had a clavate or hemispherical figure, according to the stage of their evolution. The *epithelium* consisted of large tesselated cells, which, towards the surface of the *papillæ*, were replaced by cells of minute size and polygonal form (belonging to the mucous layer).

A tumour, removed by Professor Chiari from the lips of the *uterus*, consisted of a few lobes, the largest of which was about the size of a hen's egg. It was of a light-grey colour with faint-red spots, of a lax consistence, and granular texture; the surface exhibited slight elevations and depressions; and, on section, the substance afforded, when squeezed, a milky juice, containing, as its principal morphological constituent, elementary organs resembling epithelial cells. These were of tolerably uniform size, and had an angular outline, one of the angles being occasionally protracted into a short process (fig. 168, *a*). The contents of these cells were fine-molecular; the *nuleus* oval, with a prominent *nucleolus*. The flattened, broad forms passed by degrees into the extended (*b*), the processes becoming elongated, and the middle portions or bodies of the cells slenderer, and in this way the cells approached more nearly to fibre-cells. The rounded cells (*c*) had a vesicular, clear *nucleus* without *nucleolus*; it was excentric, and encompassed by a crescentic portion of cell-contents. Multinuclear cells were also met with (*d*), essentially different from other forms (*e*), manifestly arising from agglomerations of cells. The latter are to be regarded as sectional views of papillary

growths filling the *areolæ*, formed by delicate fibrous bundles. In the transverse section of the smaller *papillæ* (at *e*), a molecular central mass may be seen, surrounded by concentric layers of flattened cells, whilst in the centre of the larger *papillæ* a molecular substance, with imbedded oval *nuclei*, is apparent. At *i*, is given a longitudinal view of one of these *papillæ*, in which the superficial, polygonal cells are brought into view after removal of the deeper layers.

FIG. 168.

The concentric colloid bodies (*f*) occurred but rarely, whilst granule-masses (one of the larger of which is represented at *g*) occurred, in many places, in considerable quantity. In these agglomerations of fat-globules, hyaline spaces (*h*) were also occasionally visible, most probably corresponding with the remains of the hyaline *nuclei* of masses of cells in a state of fatty degeneration.

In a similar growth from the *os uteri*, the medullary character was strongly expressed. The tolerably large cells were mostly of the elongated form, with comparatively large *nuclei*

and *nucleoli*. The fibrous bundles were often opened out in an infundibular manner, and in the *areolæ* thus formed, the delicate cells, flattened by mutual pressure, were lodged, not unfrequently, in the manner of a tesselated *epithelium*. In the less-organized parts of the tumour, the development merely of gelatinous masses was reached, in which were imbedded, in a hyaline, structureless, only occasionally striated *matrix*, scattered, immature connective-tissue-elements. Gangrenous, brownish-black, highly fetid portions towards the base of the tumour, contained a dirty, brownish-yellow, molecular substance, with reddish-brown masses of decomposed blood.

§ 13. Ovary and Testis.

In new-formations of connective tissue in the ovary, a great tendency is exhibited towards the formation of cysts, and the same is the case with cancerous growths in that situation. A tumour of this kind was, in one case, dilated into a sac as large as a child's head, containing blood and a gelatinous substance. The outer surface of its wall was smooth, the tissue towards the exterior firm and fibrous, and, towards the interior, of a looser texture. The united thickness of the two layers was from 2·21—2·65‴ up to 0·57″; from the outer, firmer layer, fibrous bands, having a tendinous aspect, extended towards the cavity and formed wide, infundibuliform, firm dissepiments, which seemed to serve as points of attachment for the tissues contained in the *areolæ*, and which gradually became more and more delicate and soft in their texture.

Different parts of the growth, again, exhibited the most various forms of development. One of the *areolæ*, for instance, might be seen subdivided by lateral, fibrous bundles, enclosing infundibuliform spaces between them, into loculaments, which, gradually becoming smaller and smaller, at length constituted entire systems of a progressively finer and finer network. This network, again, was occupied, either with cysts, also diminishing successively in size, or cauliflower-like (papillary) vegetations projected into, and more or less filled, the *areolæ*. These vegetations were manifestly seated in closely contiguous groups upon the fibrous mesh-work, and had a light-grey, speckled aspect, occasionally marked with bloody dots. They consisted

simply of agglomerations of cells, and it was of these groups, usually in a far advanced stage of degeneration, that were constituted the peripheral, papillary projections. The cells were of a subelliptical form, and the voluminous *nucleus* was often double. There was also a transparent sort of these papillary new-formations, surrounded by a kind of plicated membrane, enclosing contents as clear as water, and, consequently, representing pedunculated cysts. On the inner wall of these transparent *papillæ*, groups of cells and an areolar mesh-work might also occasionally be perceived.

Denser masses lying towards the interior contained cystiform cavities, some as large as a lentil, which were at once displayed when a section was made. Of considerable interest were the numerous, minute, perfectly isolated, bloody points, some of which were but just perceptible to the naked eye. These points consisted of larger or smaller groups of blood-corpuscles, closely surrounded by a perfectly closed envelope composed of several layers of concentric, *not* wavy fibres. Parallel with these fibres, might be noticed slender, oblong corpuscles, 0·00044‴ broad, and 0·0035—0·0044‴ long. There can, perhaps, be no doubt, that this fibrous tissue should not be referred to connective-tissue-fibres; in their straight course, and their not disappearing in acetic acid, the fibres most closely resembled mucin-filaments, and we also at present regard it as problematical whether the oblong corpuscles should be regarded as *nuclei*, or whether it be not far more probable that they represent coagulated mucin. In the walls of many of the cysts the blood-vessels were well developed, and after the action of acetic acid they were seen to be lined with a delicate, longitudinally striated membrane, which was succeeded by a layer of transverse and longitudinal *nuclei*, disposed at uniform distances apart. These *nuclei* were mostly 0·0052‴ long, and 0·0008‴ broad, and not unfrequently curved in an undulating manner.

The following instance will serve as a further proof that blood is formed at isolated points in the parenchyma of cancer. A tumour about the size of a small fist, situated in the *scrotum*, and which was removed by Professor Dumreicher, when cut into, presented the following appearances. Light-coloured spots, of a yellowish tinge (fig. 169, *a a*), formed islands over

the surface, often throwing out tongue-shaped prolongations, and occasionally projecting a little above the level of the interstitial, greyish-red substance (indicated in the figure by the dark shading). In each of these light-coloured masses, there existed, in the first place, numerous fat-globules and granule-masses, contained in a close-meshed, fibrous tissue. Immediately around this tissue, whose light-yellow tint was due to the quantity of *olein* contained in it, bloody points and streaks were seen in abundance (*c c*); and in the latter, the commencement of a vascular ramification might occasionally be observed.

Fig. 169.

From the greyish-red substance a very milky juice could be expressed, whose predominant element consisted of rounded cells of small size, with comparatively large *nuclei*. Multinuclear cells were frequent, as well as cells in such an advanced stage of fatty degeneration, that they were transformed into an aggregate of fat-globules with one or several light-coloured spots (corresponding to the *nuclei*.)

The parts in a state of involution were also indicated by the cretification which had taken place in them. Thus, at *b*, a rounded, hardish nodule, of the size of a small lentil, was observed containing, besides organic remains, chiefly amorphous carbonate of lime, which, after the reaction of sulphuric acid, attended with effervescence, exhibited crystals of sulphate of lime. In other places, as, for instance, at *d*, an orange-coloured pigment was collected.

This *medullary form* of *cancer*, which, as is well known, is that most frequently met with in the *testis*, is of interest as contrasted with the frequency of the cystic form in the ovary, as has been already noticed by Rokitansky. The strong areolar connective tissue which exists in the ovary as well as in the mammary gland may constitute a morphological reason for the great tendency exhibited in those organs to the formation

of cysts out of the numerous and large *areolæ*. Besides this, it is also to be noticed that the formation of cysts in cancer, indicates a high degree of development of the morbid growth, and would be in accord with the exalted formative *nisus* manifested, particularly, in the female generative organs.

§ 14. Eye.

Cancer may either originate in the eyeball itself, or the latter may become secondarily involved in a cancerous growth in the orbit.

The cancer often presents a *melanotic* form, and dark brownish-red colour. A growth of this kind was removed from the orbit by Professor v. Rosas. The abundant, flattened, dark-brown elements (fig. 170, *a*), might, from the various transitional stages, be regarded as cells in an advanced stage of pigmentation, and in which the *nucleus* was no longer apparent. The very numerous, brownish-black, irregular, usually far smaller corpuscles, on the other hand, were either defunct cells, or had arisen immediately from the cancerous *blastema* containing an abundance of *hæmatin*.

Fig. 170.

The pigment-molecules, some of which were 0·0013‴ in diameter, were lodged in the cell-contents and were never observed in the excentric *nucleus* (*vid.* the five cells at *b b*). The same thing was also noticed in the fibre-cells (*vid.* the four uninuclear cells at *c c*, and the multinuclear at *d d*); the *nucleus* itself might, even, have degenerated into a large vesicle (as at *e*). Under these circumstances it can only be conceived, that the pigment had been taken up by the cells in the fluid condition and had afterwards changed its state of aggregation. A marked proof of the independent nature of the *nucleus* is seen in the circumstance that no pigment was deposited within

it. The amount of pigment, moreover, was not uniform; and in other parts, again, the fatty degeneration predominated.

In another case, the cancerous mass, which was also lodged in the orbit, was not melanotic, and for the most part in a state of sanious decomposition; it presented *nuclei*, granule-masses, deep-yellow fat-globules, and amorphous, transparent plates; the latter, which were present in considerable abundance, were not affected by acetic acid, and were, probably, of a colloid nature. The globe of the eye, which was displaced by the cancerous growth and partially surrounded by it, was shrunken, and the *cornea* plicated, opaque, and much softened in texture; its *laminæ* readily admitting of separation. The *lens* was entirely destroyed and the vitreous humour in great part. When the latter was removed, new-formed, mostly isolated, elliptical, as well as more elongated, fusiform cells, in every variety, might be perceived in the superficial portion; they were 0·0066—0·039‴ in size, with fine-molecular contents, and after treatment with acetic acid displayed a comparatively small *nucleus*. The *retina*, so far as the time which had elapsed since death would allow of its examination, did not appear to have undergone any remarkable structural change. The optic nerve was in a good state of preservation, except that its sheath, towards the point where the cancer rested on the globe, was somewhat thickened.

§ 15. Brain and Nerves.

Cancerous growths, *infiltrating* the substance of the brain, not circumscribed by any abrupt line of demarcation, and scantily supplied with blood, usually present, especially in their cortical layers, a *firmer consistence* than that of the brain in the normal condition. The surface of a section appears, as it were, marbled with light-yellow, irregularly distributed islands, parted by a greyish-red substance, in which bloody points, streaks, and spots are, in most cases, apparent. A turbid juice may be expressed, though only in small quantity; the succulence of the morbid growths, having the consistency above mentioned, being but trifling.

The cells cannot, frequently, be distinctly seen until the texture has been carefully torn up, as they appear to be closely agglu-

of cysts out of the numerous and large *areolæ*. Besides this, it is also to be noticed that the formation of cysts in cancer, indicates a high degree of development of the morbid growth, and would be in accord with the exalted formative *nisus* manifested, particularly, in the female generative organs.

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Fig. 170.

The pigment-molecules, some of which were 0·0013‴ in diameter, were lodged in the cell-contents and were never observed in the excentric *nucleus* (*vid.* the five cells at *b b*). The same thing was also noticed in the fibre-cells (*vid.* the four uninuclear cells at *c c*, and the multinuclear at *d d*); the *nucleus* itself might, even, have degenerated into a large vesicle (as at *e*). Under these circumstances it can only be conceived, that the pigment had been taken up by the cells in the fluid condition and had afterwards changed its state of aggregation. A marked proof of the independent nature of the *nucleus* is seen in the circumstance that no pigment was deposited within

it. The amount of pigment, moreover, was not uniform; and in other parts, again, the fatty degeneration predominated.

In another case, the cancerous mass, which was also lodged in the orbit, was not melanotic, and for the most part in a state of sanious decomposition; it presented *nuclei*, granule-masses, deep-yellow fat-globules, and amorphous, transparent plates; the latter, which were present in considerable abundance, were not affected by acetic acid, and were, probably, of a colloid nature. The globe of the eye, which was displaced by the cancerous growth and partially surrounded by it, was shrunken, and the *cornea* plicated, opaque, and much softened in texture; its *laminæ* readily admitting of separation. The *lens* was entirely destroyed and the vitreous humour in great part. When the latter was removed, new-formed, mostly isolated, elliptical, as well as more elongated, fusiform cells, in every variety, might be perceived in the superficial portion; they were 0·0066—0·039‴ in size, with fine-molecular contents, and after treatment with acetic acid displayed a comparatively small *nucleus*. The *retina*, so far as the time which had elapsed since death would allow of its examination, did not appear to have undergone any remarkable structural change. The optic nerve was in a good state of preservation, except that its sheath, towards the point where the cancer rested on the globe, was somewhat thickened.

§ 15. Brain and Nerves.

Cancerous growths, *infiltrating* the substance of the brain, not circumscribed by any abrupt line of demarcation, and scantily supplied with blood, usually present, especially in their cortical layers, a *firmer consistence* than that of the brain in the normal condition. The surface of a section appears, as it were, marbled with light-yellow, irregularly distributed islands, parted by a greyish-red substance, in which bloody points, streaks, and spots are, in most cases, apparent. A turbid juice may be expressed, though only in small quantity; the succulence of the morbid growths, having the consistency above mentioned, being but trifling.

The cells cannot, frequently, be distinctly seen until the texture ... n carefully torn up, as they appear to be closely agglu-

of cysts out of the numerous and large *areolæ*. Besides this, it is also to be noticed that the formation of cysts in cancer, indicates a high degree of development of the morbid growth, and would be in accord with the exalted formative *nisus* manifested, particularly, in the female generative organs.

§ 14. Eye.

Cancer may either originate in the eyeball itself, or the latter may become secondarily involved in a cancerous growth in the orbit.

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tinated by some connective medium; they are small, and mostly elliptical or oval. Fibre-cells, with two or several short processes, occur in, comparatively, small number. The narrow-meshed, fibrous *stroma* is, in most places, so concealed by fatty molecules, that the fibrillar structure is distinctly visible only in very thin layers. This fatty degeneration of the cancerous *blastema* is also manifested in the cells, and, owing to their close aggregation, is without doubt the cause of the light-yellow spotted appearance. The sharply defined, in many places, numerous, bloody points, may be readily dissected out and shown to be closed, sinuous blood-sacs, furnished with processes and independent walls, like those figured above (fig. 157). They are imbedded in a mass of light-grey, minute *nuclei* and may be regarded as the starting points of arborescent blood-vessels. Those portions of the cancer which are further advanced in involution exhibit a considerable abundance of free, orange-coloured and brownish-red pigment-granules, or groups of amorphous calcareous salts.

The boundaries of the morbid growth are sharply defined in those cases in which a very *vascular capsule* of connective tissue surrounds the mass and provides for its nutrition. From this capsule, processes are continued into the interior of the tumour, which is usually softer than the preceding form, exhibits an exquisite medullary character, and is reddened by an abundance of blood. The cells, most of which are of the fusiform kind, are readily liberated. A dendritic, trabecular tissue, consisting of fibre-cells in close apposition, pervades the tumour, forming considerable-sized *areolæ*. The blood is either enclosed in thin-walled vessels, or free in the *parenchyma*; and sometimes, in fact, exists in such quantity as to produce the form of *cancer* termed by many authors "blood-sponge" (Blutschwamm). The combination of the medullary form with the development of a few cysts, and with osseous tissue, occurs but rarely.

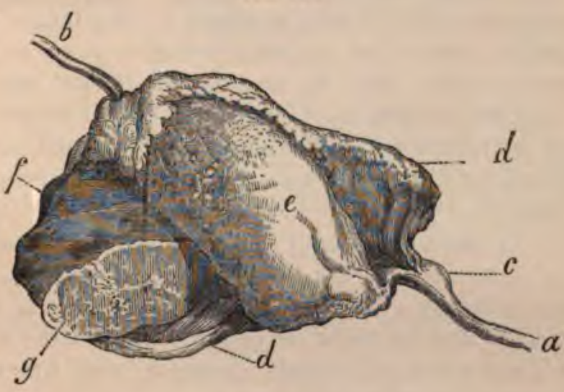
Moreover, that tumours of this kind, when their growth is excessive, may embrace and include isolated portions of the brain, is obvious enough, from the circumstance that masses are met with in the parenchyma of the tumour evidently composed of brain-substance.

The cerebral substance immediately surrounding the can-

cerous deposit, appears, in many spots especially, more succulent than is natural, and infiltrated with a gelatiniform substance, or with a turbid fluid. In the latter case, some injection of the vessels will be perceived, and, occasionally, small hemorrhagic effusions. Numerous, granular corpuscles are lodged in the rarefied and softened cerebral substance.

Cancerous deposits are sometimes observed in the continuity of a nerve; as such we regard a tumour described by Professor Schuh as a *neuroma* in the ulnar nerve. It was of an oval shape, and nearly 2·3‴ long. If a line were imagined drawn between the upper and lower portions of the nerve, separated from each other by the tumour, it would not correspond with the longitudinal axis of the growth. The tumour had a connective-tissue-capsule (fig. 171, *d d*), which was continuous with the

Fig. 171.



upper (*a*) and the lower (*b*) portions of the ulnar nerve. The tumour, which was somewhat slenderer above, could be readily enucleated from this capsule by the finger, though, here and there, fragments of the softer cortical substance were left adherent. Its surface (*e*) was of a dirty flesh-colour, and marked with slight elevations and depressions. A vertical section, carried through the longitudinal axis, showed that the peripheral part was less consistent than the central; and also, that the latter was of a dirty, grey-red colour, and contained sharply defined, light-yellow, speckled portions, not unlike the usual *reticulum* of cancer (*g*). Nor were blood-tinged spots and

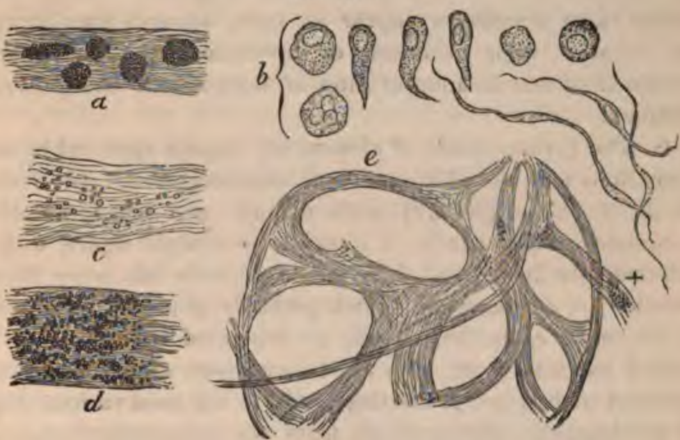
streaks wanting (*vid. f*, which corresponds to the vertical section of the lower fourth of the tumour).

With respect to the passage of the nerve into the connective-tissue-capsule, it must be remarked, that immediately above the tumour, a fusiform enlargement (fig. 171, *c*) existed, corresponding to an analogous, smaller enlargement at the insertion of the lower portion (*b*). The greater nodule retained to some extent the striated appearance peculiar to the larger nerves, when divided longitudinally; whilst this appearance was wanting in the lower nodule. In the latter, the existence of primitive nerve-tubes could only be demonstrated after careful treatment with potass, whilst, in the upper nodule, a considerable number of primitive tubes could be perceived among the numerous fibres of connective tissue, and could be traced downwards into the sheath of the tumour. On the radiating filaments, continued from the nodules into the capsule, besides the nerve-tubes, globules might be seen, arranged in longitudinal series. These globules, which had the same refractive power as coagulated nerve-medulla, must be regarded as defunct nerve-substance. In the capsule itself, in several places where it was examined, nothing but connective-tissue-bundles, and numerous imbedded elastic fibres, with an abundance of fat among them, in the form of large globules, granule-masses, and irregular collections of molecules, could be discerned. Thus all connexion by nerve between the upper and lower portions of the trunk was interrupted. The two nodules arose in a local hypertrophy of the interstitial connective tissue of the trunk of the nerve, and are in all respects analogous with the nodular enlargements in an amputated stump.

The predominant, organized elementary constituents were spheroidal, delicate, granular cells, of 0·0057—0·0088‴ in diameter, with a single or multiple *nucleus*. The caudate and fusiform cells, which were less numerous, had an oval *nucleus* (*vid.* the various kinds of cell-forms in fig. 172, *b*); the fibrous *stroma* in which they were imbedded, was composed, towards the periphery, of delicate bundles, whilst those in the more consistent, central layers were thicker, and presented a distinctly areolar arrangement (*e*); here and there brownish-red pigment-molecules lay upon the fibrous bands (as at + in *e*). The reddened parts occasionally presented blood-vessels, form-

ing close mesh-works. Both substances abounded in free fat, especially in the light-yellow, denser spots, which, together with

FIG. 172.



a large quantity of fatty molecules, contained cholesterin-plates. In the fibrous bundles, which could be more or less readily drawn out, were lodged variously formed, fatty granule-masses, derived from cells in a state of fatty degeneration (*a*), or solitary fat-granules, in greater or less number (*c*, *d*).

CONCLUDING OBSERVATIONS WITH RESPECT TO NEW-FORMATIONS.

1. Every new-formation requires an *increased transudation.*

2. The *blastema* (*plasma, exudation*) requires, for its organic development, a *parent-stroma.*

3. The *formation* of *cells* is either *free* (originating in the *blastema*), or is due to a process of *multiplication,* starting from the parent-organ; in the course of which, certain structural portions of the parent-stroma are often developed at the expense of the others which remain at an embryonic stage of development, so that the morphological type of the new-formation differs from that of the parent-organ.

4. The *cell-formation* may be *complete* or *incomplete ;* if the

latter alone exist in a new-formation, it indicates, in most instances, a rapid development, and great tendency to diffusion throughout the organism.

5. There are *no* such things as *heteroplastic cells*. What makes them sometimes appear as such, depends simply upon an excess in their evolution or involution; the fundamental character of one or another kind of normal cell being always retained.

6. The various kinds of elementary organs apparent in new-formations are: *a*, white and red blood-corpuscles (the former identical [isomorphous?] with mucus- and pus-corpuscles); *b*, connective-tissue-cells, of rounded or straight figure, with all intermediate forms, and their metamorphosis into wavy fibrous bundles; *c*, elastic fibres, most probably produced from cells; *d*, fat-cells; *e*, epithelial cells of depressed (flattened) or extended (conical) form, with all intermediate shapes, sometimes crowned with *cilia*; *f*, cartilage-cells, in the most various stages of development, distinguished from the connective-tissue-cells by the metamorphoses they undërgo in the process of ossification; *g*, bone-corpuscles, always arising from cells; *h*, contractile fibre-cells (organic muscular fibre-cells); *i*, transversely striped muscular fibres, observed by Rokitansky in the *testis*, and by Virchow in the ovary; *k*, nerve-tubes, observed by Virchow; *l*, gland-cells; *m*, elements of dentin and enamel; *n*, the granulous corpuscles, granule-cells, and so-termed tubercle-corpuscles are referrible to cell-formations, either in a state of involution or incompletely developed.

7. From these elements, again, *new-formed organs* are composed, such as systems of blood-vessels, which are always associated with new-formations of connective tissue, and doubtless have the most essential influence on the capacity of the new-formation for further development; and this is especially the case with the more highly developed vascular systems on the outer wall of cysts, the *blastema* upon whose inner surface thence acquires a more exalted germinative power. In this way are developed the embryonic parenchyma of the thyroid gland, skin with hairs, sebaceous and sudoriparous glands, teeth and bones.

8. There is but *one large family* of *new*-formations, the different members of which are associated in manyways, and should be

described as constituting so many categories. For these the names commonly in use—as tubercle, cancer, connective-tissue-new-formation, osteophytes, &c.—should be retained, but the different growths must not be regarded, as by nature and essentially, definite *species*. Viewed in one sense, the combined forms may be placed in one category, and in a second point of view, in another. The names are necessary for the description of the direction and form of the development, but must not be taken to express ideal entities.

9. In all new-formations the *asymmetrical conditions* exhibited both in their development and in their retrogression are, in general, very remarkable.

10. Among the compound new-formations, the papillary, papillo-dendritic, and areolar *types of tissue* predominate.

11. The *reaction* of the new-formations upon the *parent-organ* consists in a fusion of the latter, in consequence of an excessive formation of *blastema*, and in its atrophy consequent upon the closure of the nutrient canals; and these effects are frequently associated with a hypertrophy of a corresponding part of the contiguous tissue.

12. The idea of *malignancy* of new-formations is only relative; it is connected with a *dyscrasis* of the blood which has not yet been elucidated. *Cancer* and *tubercle*, which are chiefly regarded as malignant new-formations, not unfrequently occur isolated, and occasionally exhibit no tendency to disintegration; whilst, on the other hand, the new-formations of connective tissue usually reckoned among non-malignant growths (such as *lupus*, and those which occur in *syphilis*), may occasionally so far present the malignant character, that they undergo disintegration and are manifested simultaneously in several organs. Every member of the family of new-formations may, according to circumstances, be malignant or non-malignant, as has been admitted long since with regard to *pus*.

13. The by no means unfrequent *combinations* of new-formations, as, for instance, of *pus* and connective tissue, of *cancer* and tubercle, also point to the law expressed in the eighth proposition, that the new-formations belong to a large family and are not rigorously distinct from each other.

14. The new-formations of connective tissue can usually be shown to arise from a parent *stroma* of a similar nature; the

form in which they are developed depending upon the circumstance whether they arise at isolated points or in larger groups. In the former case, they are prone to assume the papillary and papillo-dendritic type, especially when they are developed in natural cavities, or on the inner surface of pathologically formed *areolæ* (cysts and fissure-like hollows). In the second case, they exhibit a more or less well marked lobate form, with an areolar framework.

15. The same peculiarities are also met with in the morbid growths described as *cancer*; consequently a great analogy between them and the new-formations of connective tissue cannot but be recognized. As regards its morphological characters, *cancer* is distinctly manifested only when—*a*, the spontaneous involution is evidenced in all parts by a chiefly fatty degeneration of its elementary organs and of the *blastema*; *b*, when a malformation and multiplicity of forms are manifested in its cells; *c*, when a diversity of development and of retrogression of various tissues is exhibited in different parts, as connective tissue, blood, blood-vessels, cartilage, and bone. The fundamental character of *cancer* is that of a malformed (aborted) and degenerating new-formation of connective tissue.

16. It happens in connective-tissue new-formations, also, that particular parts may exhibit a tendency to involution, evoked by partial, imperfect, nutritive conditions; and, occasionally, likewise the malformation of its elementary components is evident. Whence, after all, it results that only a distinction of degree exists between *connective-tissue new-formations and cancer*, even in the above respects.

17. *Blood* and *blood-vessels* are developed in all new-formations, capable of a high degree of organization. The blood may arise either primarily, without any previous organic receptacle, or secondarily, in such a receptacle. The new-formed blood-vessels are usually characterized by the simplicity of their structure. The character of the vascular ramification is, most frequently, analogous to that of the vessels in connective tissue in all its varieties: *a*, straight, when the vessels run in parallel, alternately larger or smaller, undulating curves, give off but few branches, and, when occurring in dendritic vegetations, form bundles of loops in the *apices* of the growth; *b*, their course may be abruptly convoluted, with nume-

rous short terminal loops—these occur in new-formations of connective tissue having a minutely lobular structure; *c*, a radiating arborescent ramification may be observed towards the base of cauliflower excrescences; *d*, the most highly developed vascular ramifications occur in the outer wall of cysts, and give rise to new-formations of organs, such as hairs, sebaceous and sudoriparous glands, &c.; *e*, new vessels are formed in parts in a state of hypertrophy, which retain the type of distribution proper to the affected tissue.

18. *New-formations of bone* are developed from bone, or from the soft tissues, and, in the latter case, they constitute, sometimes tumours composed of connective tissue, sometimes of a cancerous nature. The form is precisely analogous to that of connective-tissue new-formations—a papillo-dendritic—(in which case the bone-spicules also assume a lamellated disposition), and an areolar. Besides this *discrete* form, there is also a *concrete* (compact), arising, as it were, from a fusion of the former, and presenting a lobulated (often cauliflower-like) aspect. A system of medullary canals is always developed in the concrete form, which are continuous with the blood-vessels of the parent-tissue.

19. In several organs, as, for instance, in the sexual glands, the new-formations attain to a high degree of development. Many organs, such as the spleen, are rarely the seat of new-formations, especially of the more highly developed class.

THE END.

DESCRIPTION OF FIGURES.

Fig. 1, p. 92.—Crystals of uric acid. (*a*) Rhomboidal, truncated, hexahedral, and laminated crystals.; (*b*) rhombic prism; horizontally truncated angles of the rhombic prism; imperfect rhombic prisms; on the last crystal in this row is seated a group of rectangular crystals; (*c*) prism, with a hexahedral basal surface—barrel-shaped figure; prism with a hexahedral basal surface; (*d*) cylindrical figure; stellate and superimposed groups of crystals. × 300 diam.

Fig. 2, p. 97.—The orange-yellow, fine sand in the medullary substance of the kidney in a new-born child affected with jaundice (urate of ammonia). (*a*) Divergent, broad, irregular black streaks, with lateral branches and twigs, imbedded in the tubular substance, × 60 diam.; (*g*) angular molecules aggregated into minute black masses, × 350.

Fig. 3, p. 97.—Urate of ammonia in the form of globules. (*b*) Urate of soda in stellæform of needles. × 350 diam.

Fig. 4, p. 101.—The more usual crystalline forms of the triple phosphate of magnesia and ammonia: various metamorphic, hemihĕdral forms of the fundamental figure—the rhombic vertical prism. × 300 diam.

Fig. 5, p. 102.—Quadratoctahedrals of oxalate of lime. (*b*) The basal plane of the octahedron forming a rectangle; (*c*) compound forms; (*d*) imperfect forms. × 300 diam.

Fig. 6, p. 104.—Carbonate of lime in the amorphous condition, from the cataractous crystalline lens of an old horse. (*a*) Nodular mass, × 60 diam.; (*b*) solitary and grouped granules, × 350 diam.

Fig. 7, p. 106.—Crystals of sulphate of lime obtained artificially by the action of dilute sulphuric acid upon carbonate of lime, and forming fasciculate needles, six-sided columns, occasionally with truncated edges and angles. × 350 diam.

Fig. 8, p. 108.—Imperfect crystalline formation of salts, readily soluble in pathological fluids (foliate). × 350 diam.

Fig. 9, p. 108.—Imperfect crystalline forms of salts, readily soluble in pathological fluids, also obtained by evaporation (fern-like). × 350 diam.

Fig. 10, p. 112.—Cholesterin-plates, (*a*) regularly laminated and viewed rather obliquely; at +, in the middle solitary plate, one side is truncated; (*b*) irregularly laminated, partially injured forms. × 300 diam.

Fig. 11, p. 114.—Hæmatoidin-crystals. (*a*) Larger forms, oblique rhombic prisms; at +, oblique six-sided prisms; (*b*) smaller forms. × 350 diam.

Fig. 12, p. 116.—Hæmatin in the vessels of the mucous membrane of the duodenum in *cholera*. (*a*) Brownish-black granules, apparent in the blood which has been washed away; (*b*) similar granules, accumulated to such an extent that the *lumen* of the vessel is obstructed; (*c*) minute dark granules among the white blood-corpuscles. × 350 diam.

Fig. 13, p. 122.—Organic remains in an intestinal concretion. (*a*) Elongated vegetable parenchymatous cells; (*b*) vegetable hairs; (*c*) a thicker spiral; (*d*) a thinner spiral; (*e*) egg of *Trichocephalus dispar*; (*f*) egg of *Ascaris lumbricoides*. × 300 diam.

Fig. 14, p. 131.—Atrophied fat-cells from the sub-cutaneous tissue of an aged, much emaciated individual. (*a*) Fat-cell, shrunken, with crumbling, dark brownish-yellow contents; beneath it, one of lighter colour, with crystals radiating towards the border; (*b*) an atrophied, pigmented fat-cell in apposition with one in the normal condition; (*c*) cells filled with a serous fluid, and presenting in their contents well-marked circles (fat-globules in suspension) and delicate, oval, simple or double granules (*nuclei*); (*d*) cells containing serum, and whose walls are laminated. × 350 diam.

Fig. 15, p. 132.—Atrophied fatty tissue from the capsule of a gelatinous sarcoma. (*a a*) Rows of atrophied fat-globules, for the most part without any cell-membrane; (*b*) groups of normal fat-cells accompanying the above; (*c*) enlargements and bifurcate division of the elastic filaments running among the rarefied fat-cells. × 350 diam.

Fig. 16, p. 135.—Atrophied bronchial cartilage in chronic catarrh. (*a*) Cartilage cells containing a pigmented molecular mass, with which eventually the whole cell is filled; (*b*) cartilage cells containing large fat-globules; the pigment in the intercellular substance partially concealing the cells; (*c*) parent-cell, with two secondary cells containing large fat-globules. × 350 diam.

Fig. 17, p. 136.—Atrophied bronchial cartilage in *tuberculosis*. (*a*) The side corresponding to the sub-mucous tissue; (*b*) that looking towards the external connective-tissue coat; (*c*) dark brownish-yellow material, in some places wholly concealing the fatty cartilage-cells. × 60 diam.

Fig. 18, p. 136.—Articular cartilage from the upper end of an osteoporotic *tibia*. The intercellular substance is fibrous, and at *a*, split up into *fibrillæ*; the cartilage-cells contain numerous brilliant molecules. × 350 diam.

Fig. 19, p. 138.—Macerated, thyroid cartilage in a case of cystic bronchocele. (*a*) Thick-walled cells; (*b b*) elongated fat-drops of the intercellular substance. × 350 diam.

Fig. 20, p. 139.—Pathologically metamorphosed cells of the tracheal cartilage (*a*, *c*) with thickened walls; (*b b*) forms interrupted in their development into secondary cells; between *b b*, and at *c*, are granule-masses; (*d*) parent-cell, containing pigment-substance accumulated towards one side, and secondary cells enclosing fat-globules. × 350 diam.

Fig. 21, p. 143.—Transverse section of a necrosed portion of the *tibia*. (*a a*) Medullary canals divided transversely; (*b b b*) dark brown-yellow pigmented portions, situated especially at the junctions of the systems of bone-corpuscles; (*c c*) radiating bone-canaliculi. × 90 diam.

Fig. 22, p. 145.—Disintegrated muscle (pathologically diminished cohesion); (*a*) primitive fasciculus torn across; (*b*) primitive fibrillæ hanging out. × 350 diam.

Fig. 23, p. 145.—Muscular substance of the heart in a state of fatty degeneration. The transverse striation of the primitive fasciculi is destroyed, and a greater or less abundance of fat-globules is collected between them. × 350 diam.

Fig. 24, p. 148.—Fatty degeneration of the elementary organs in the cerebral vessels of an aged individual, dead of apoplexy. (*a*) Two branches of a capillary vessel on a single trunk, with a double layer of *nuclei;* (*b*) somewhat thicker subdivided trunk; (*c*) minute arterial vessel. In all three, fatty molecules are deposited in the walls. × 350 diam.

Fig. 25, p. 150.—Transverse section of the popliteal artery of a sexagenarian woman, affected with gangrene of the feet. (*a*) The portion corresponding to the innermost layers, (*b*, *c*, and *d*) belong to the annular fibrous coat; at (*d*) are seen layers of fat in a state of minute division, disposed concentrically around the vessel; (*e*) connective-tissue-sheath. × 300 diam.

Fig. 26, p. 158.—Portion of a dried emphysematous lung viewed by reflected light. In it are seen cæcal cavities of various size and form, corresponding to groups of atrophied air-cells. × 4 diam.

Fig. 27, p. 162.—Small metamorphosed cells from a fatty liver, in chronic tuberculosis. Those in the uppermost row contain pigment, the others *olein.* × 300 diam.

Fig. 28, p. 164.—Interlobular fatty liver (nutmeg liver). (*a*) Large quantity of free fat-globules between the lobules; (*b* and *c*) parts in which the portal capillary system, filled with blood, is apparent. × 60 diam.

Fig. 29, p. 165.—Pigmented nutmeg-liver. (*a*) A lobule with the *vena centralis* (*intralobularis*) divided nearly in its longitudinal axis, at *; the vein contains an amorphous pigment-substance; (*b*) lobule showing the central vein empty, and divided transversely; (*c*) lobule with the central vein divided nearly transversely, and filled with pigment. A pigmentation resembling a capillary plexus is seen around the central portion of the lobules, caused by the collection of pigment-molecules towards one side of the hepatic-cells. × 90 diam.

Fig. 30, p. 170.—Placental *villi* filled with a greyish-brown molecular substance, taken from an aborted fœtus, 18 inches long. (*a*) *Villus* with its clavate end entirely filled with a fine-granular opaque material; (*b*) one only partially so filled at the summit. × 300 diam.

Fig. 31, p. 172.—Chorion belonging to an *ovum* at the eighth or tenth week, in a state of serous and fatty degeneration. (*a*) A *villus*, much enlarged towards its clavate extremity, covered with large oval *nuclei* of the epithelium; seated upon it are two other *villi*, one globular and the other of a retort shape; (*b* and *d*) outlines of enlarged extremities of *villi*, with the punctated hyaline spaces, *c c c* and *e e*; (*g*) stem of a *villus*, with fibre-cells, in a state of fatty degeneration; (*h*) granule-masses, which in many places entirely cover the stem of the *villus*. × 300 diam.

Fig. 32, p. 174.—Dropsical *chorion*. (*a*) *Villus* from an *ovum* at four weeks; (*b*) young *villus*, from the same; (*c*) immature connective-tissue-elements; (*d*) *villus* from a *mola hydatidosa*. × 300 diam.

Fig. 33, p. 175.—Dissolved *embryo*, at about the third month. (*a*) Outline of the *chorion;* (*b*) collapsed amnion, the upper half of which has been removed; (*c*) the umbilical vesicle on its outer surface; the navel-string (*e*) projected into the cavity of the amnion, with a fimbriated body hanging from it. Nat. size.

Fig. 34, p. 175.—Vesicular *œdema* of the umbilical cord of an embryo, about 0·785″ long. Nat. size.

Fig. 35, p. 182.—Cataractous lens of an old man, the cortical portion, clouded and of a grey colour. On the anterior surface are several radiating furrows; the nuclear portion transparent. × 4 diam.

Fig. 36, p. 183.—Lens with central opacity, from a Rabbit. (*a*) Posterior surface; (*b*) lateral view. × 2 diam.

Fig. 37, p. 191.—Wartlike *nævus maternus;* hypertrophied *papillæ.* (*a*) Epidermis-cells, whose *nuclei* were completely concealed by a blackish-brown pigment; (*b*) epidermis-cells, with the *nuclei* only partially surrounded with pigment; (*c*) cells without pigment; (*d*) reddish-brown pigment in the substance of the *papilla;* (*e*) scattered nucleiform bodies; (*f*) a wavy vascular loop. × 350 diam.

Fig. 38, p. 195.—Elementary structures in a hypertrophied heart. (*a*) A subdividing fasciculus, with dirty-yellow pigment molecules in the *sarcolemma;* (*b*) a slender dichotomous fasciculus; (*c*) anastomosing muscular fibre; (*d*) laminated, (*e*) smooth colloid corpuscles. × 350 diam.

Fig. 39, p. 197.—Transverse section of the hypertrophied muscular coat of the stomach, boiled in acetic acid and dried. (*a a*) Organic muscular fibres, divided transversely; (*b b*) connective-tissue-bundles. × 350 diam.

Fig. 40, p. 200.—Fibrinous *stroma* of an exudation in the pericardium. (The symptoms of *pericarditis* had existed only a few days.) × 450 diam.

Fig. 41, p. 201.—Vascular injection in the subserous tissue in *peritonitis.* (*a*) Congested vessels in the longitudinal layer of organic muscular fibres of the intestine; in the upper part of (*b*) are seen the vessels of the adipose layer, and in the lower, those of the submucous tissue. × 15 diam.

Fig. 42, p. 203.—Laminated, soft pleuritic exudation, constituted of superimposed plates, with numerous imbedded olein- (fat-) globules, cholesterin-plates, and calcareous salts. × 350 diam.

Fig. 43, p. 204.—Cretified pleuritic exudation. (*a*) Calcareous salts in the botryoidal form, placed in groups; (*b*) smaller forms of the same kind; (*c c*) long, opaque, occasionally bifurcating streaks (obliterated blood-channels ?), and between them dark fissure-like vacuities and spaces. × 350 diam.

Fig. 44, p. 207.—Perpendicular section of the skin of the thigh in a case of *variola.* (*a, b*) Papillary stratum after removal of the *epidermis;* the dark parts represent sanguineous spots; (*c*) opaque epidermis; (*d*) layer of hyaline exudation; (*e*) exsanguineous *corium,* with its areolar fibrous tissue; (*f*) adipose tissue; (*g*) hair-bulb surrounded with fat-cells. × 15 diam.

Fig. 45, p. 209.—Membranaceous deposit obtained by the heating of the clear fluid in *pemphigus.* (*a*) The plicated membrane expanded; (*b*) the same rolled up. × 800 diam.

Fig. 46, p. 212.—Varicose cutaneous vessel of the *anus.* (*a*) Saccular dilatation, sometimes of a flask shape, sometimes with lateral bulgings, in the veins of the subcutaneous cellular tissue; (*b*) the papillary stratum removed horizontally, whose vessels are also in the dilated condition; the light-coloured groups of *papillæ* exhibited in their interior, sinuated red spots—vascular loops, × 60 diam.; (*c*) varicose vessels in the *caput trigonum vesicæ,* × 300 diam. (belonging to the mucous membrane).

Fig. 47, p. 213.—Streaked, consistent exudation-layers in a case of hydrocele, in parts where the skin of the scrotum was destroyed. (*a*) Horizontal dirty-yellow layers, with imbedded pigment-granules; (*b*) another place, in which brownish-yellow, pigmented, spherical or elongated bodies were apparent between the layers. × 300 diam.

Fig. 48, p. 214.—Vascular congestion and sugillation of the mucous membrane of the small intestine (*cholera*). (*a*) *Villus,* with the hyperæmiated capillary plexus, and the central recurrent vein; (*b*) *villus,* with lateral recurrent vessels, × 150 diam.; (*c*) disposition of the recurrent veins in four villi,

× 25 diam.; (*d*) sanguineous suffusion of the mucous membrane of the small intestine; the light, oval spaces correspond to the Lieberkühnian glands, × 50 diam.

Fig. 49, p. 218.—Oval, delicate, granular bodies, without cell-membrane and *nucleus*, in an exudation on the intestinal mucous membrane; (*b*) summit of a *villus*, with large, opaque pigment-granules; at +, the recurrent vessel; (*c*) the summit of a *villus*, filled with fine brownish-yellow molecular substance; (*d*) a similar part, with scattered granule-masses. × 300 diam.

Fig. 50, p. 220.—Vascular injection around an enlarged solitary gland of the intestine, in typhus. (*a*) Closed, enlarged capsule, with the looped capillaries; (*b b*) groups of *villi*, with the recurrent, congested vessels; (*c c c*) larger veins of the submucous tissue, into which the coronary venules of the gland (*a*) empty themselves. × 20 diam.

Fig. 51, p. 227.—Aneurism of the aorta. (*a*) *Laminæ* taken from the inner layer of the vessel, resting upon the atheromatous deposits; grouped and solitary fat-globules are interspersed between the *lamellæ;* (*b*) horizontal section of a cretified part, presenting irregular spaces, of various dimensions, filled with carbonate of lime. × 350 diam.

Fig. 52, p. 239.—Hyperostosis of the occipital bone, in a case of syphilis. (*A*) Horizontal section; (*a a*) dense, external table, the internal containing dilated *cancelli* filled with fat (viewed by reflected light), × 3 diam.; (*B*) in the middle is an elongated *cancellus*, nearly filled with fat, and divided transversely, surrounded with light-coloured bone-corpuscles, whilst those represented at *C*, from the outer table (*a a*), are filled with calcareous salts, and opaque. *B* and *C*, × 350 diam.

Fig. 53, p. 243.—*Areolæ* filled with colloid, from three lobules of the thyroid gland in an individual suffering under *tuberculosis*. × 15 diam.

Fig. 54, p. 246.—Elements of the thymus-gland of a new-born child affected with *pemphigus*, enclosed in layers of colloid. (*a a*) Corpuscles furnished with several, peripheral, concentric layers, and containing a central substance, either molecular or constituted of minute *nuclei;* (*b*) one or several partially nucleated elements imbedded in the hyaline central substance; (*c*) a group of brownish-yellow globules, closely surrounded by layers of colloid; (*d, e, f*) colloid masses, enclosing several elementary bodies of various forms and disposition. × 350 diam.

Fig. 55, p. 257.—Different corpuscles, in the urine of a woman suffering under *eclampsia*. (*a*) Cylindrical, exudation-*coagulum* (so-termed fibrinous cylinders?); at +, epithelium from the *tubuli uriniferi;* (*b*) flattened brownish-red epithelial cells; (*c* and *e*) urate of ammonia; (*d*) botryoidal crystalline forms (?); (*f*) chloride of sodium (distinguished from oxalate of lime by its solubility in water). × 350 diam.

Fig. 56, p. 260.—Malpighian corpuscle with granular investment, from the kidney of a woman, who died on the fourth day of *eclampsia parturientium*. × 300 diam.

Fig. 57, p. 262.—Fatty degeneration of the epithelium of the *tubuli uriniferi*. (*a*) *Tubulus*, crammed full of larger and smaller fat-globules; at the lower part, the folded *membrana propria* may be seen; (*b*) *tubulus uriniferus* filled with minute fat-globules, and, in parts, quite opaque; (*c*) transverse section of a *tubulus uriniferus;* the *lumen* occupied by the accumulated fat-globules; (*d*) transitional forms of the epithelial cells in a state of fatty degeneration; (*e*) contents of many of the *tubuli;* hyaline substance with fat globules imbedded in it; (*f*) imperfect, brownish-yellow, crystalline forms of uric acid from a *tubulus uriniferus*. × 350 diam.

Fig. 58, p. 265.—Radiated colloid-corpuscles from the cysts in an atrophied kidney. (*a*) Streaks radiating from a central point; (*b*) a radiated corpuscle, surrounded with a clear border (*b'*); (*c*) a radiated corpuscle with a central, granular substance, and a border (*c'*) presenting segments of rays, parted from the inner set of rays by a line of demarcation; (*d*) besides the layers of the original corpuscle, a peripheral, transparent border is exhibited (*d'*); (*e*) a corpuscle with two granular globules in the centre. × 350 diam.

Fig. 59, p. 269.—Concentric colloid corpuscles, in the dilated ducts of the enlarged prostate, with a peripheral, concentric striation, and a central molecular substance, in which granular globules or nucleiform elements are imbedded. × 300 diam.

Fig. 60, p. 270.—From the prostate. (*a* and *b*) Botryoidal forms of calcareous salts (carbonate and phosphate of lime); (*c*) calcareous particles, enclosed in a laminated colloid mass; (*d* and *e*) calcareous salts in the botryoidal form, encysted, as it were. × 350 diam.

Fig. 61, p. 274.—*Villi* from the *placenta* of a six months' fœtus. (*a*) The walls of the capillary plexus, covered with a fatty, molecular matter; the same is seen at (*b*); (*c*) represents a peripheral, broad, light border, and the central substance in a state of degeneration; (*d*) an atrophied *villus*, in which the contents of the vessels are transformed into brownish-black pigment. × 300 diam.

Fig. 62, p. 282.—Colloid corpuscles from the choroid. (*a*) Elliptical or oval, structureless forms; (*b*) three corpuscles, with a homogeneous or granular border, the hyaline mass containing a group of fat-globules; (*c*) filled with a red-brown, granular substance; (*d*) aggregation of fat-globules; (*e*) larger, bordered body; (*f*) biscuit-shaped form; (*g*) one furnished with a peripheral, unequally thick, granular layer. × 350 diam.

Fig. 63, p. 288.—Granular corpuscles among the primitive nerve-tubes, from the lumbar portion of the spinal cord, in a paraplegic individual. × 350 diam.

Fig. 64, p. 291.—Granule-masses and elementary granules deposited on the outer wall of blood-vessels of different sizes, taken from an old encephalitic deposit in the *corpus striatum*. × 350 diam.

Fig. 65, p. 297.—Pus, in a state of incipient fatty degeneration, from an extensive subcutaneous abscess, and containing:—(1) granular globules (pus-corpuscles) with scattered, brilliant molecules in their contents; (2) red blood-corpuscles, with an even or uneven border; (3) fat-globules, appearing like sharply defined circles; (4) coagulated protein-substance, in the form of an elongated *sacculus*, beset with molecules; (5) two epidermis-cells with an oval *nucleus*. × 350 diam.

Fig. 66, p. 301.—Viscid, greyish-yellow *sputa* of pneumonia, treated with dilute acetic acid. (1) Pale pus-corpuscles, with scarcely distinguishable outlines, and the characteristic [?] *nuclei* (1 to 5); (2) *mucin* in the form of fine, straight filaments, represented, on account of their delicacy, by lines of points; (3) granular globules, furnished with an investing membrane, filled with occasionally pigmented contents, and having no *nucleus*. × 350 diam.

Fig. 67, p. 305.—Slough from a carbuncle. (*a a*) elastic filaments; (*b*) connective-tissue-bundles. × 350 diam.

Fig. 68, p. 316.—Tubercle under the *peritoneum*. (*a*, *b b*) Three tubercular "efflorescences," cut off, together with the surrounding vessels, which run in a radial manner, and send off minute twigs upon the tubercle (these are not new-formed blood-vessels), × 15 diam.; (*c*) concentrically laminated colloid corpuscle, with a granular central substance; (*d*) imperfectly organized elements; (*e*) protein substance in the solid state; (*f*) granule-masses. × 350 diam.

Fig. 69, p. 317.—The vessels beneath the *pleura*, forming a close network filled with blood. (*a a*) Two tubercles, upon which delicate vessels are seen running; (*b*) a somewhat larger nodule, divided into two halves by a transverse extravasation of blood; (*c, d, e*) hemorrhagic effusions of various sizes. × 15 diam.

Fig. 70, p. 321.—Miliary tubercle of the lung. (*a*) Flattened cells; (*b*) *nuclei*, occasionally surrounded with a circle of molecules; both are contained in the air-cells (*c*) which they completely fill. × 350 diam.

Fig. 71, p. 322.—A pulmonary lobule, infiltrated with tubercular matter, and exhibiting—(*a a*) imperfect cell-formations, remains of epithelium and fat-globules; (*b b*) stronger bundles of pulmonal fibres, which retain their character distinctly in the pultaceous mass. × 350 diam.

Fig. 72, p. 326.—Miliary tubercle on the surface of the liver. (*a a a*) Tubercles, slightly projecting aboev the peritoneal coat, with a central dark spot; (*b b*) light-yellow, and (*c c*) brownish-red hepatic substance. × 4 diam., and viewed by reflected light.

Fig. 73, p. 328.—Miliary tubercles, with surrounding vascular injection in the kidney; (*a, b, c*) tubercles encompassed by a capillary plexus; (*d*) point of union of several peripheral veins; (*e*) size and shape of the reddish Malpighian bodies, as they were obscurely seen through the substance; (*f f'*) interstices, in which the vessels were not injected with blood. × 15 diam. (by reflected light).

Fig. 74, p. 332.—Organized new-formations in the "typhus-deposit" from the submucous tissue of the lowest part of the *ileum*. (*a*) Four sub-elliptical cells with an excentric *nucleus;* (*b*) four sub-elliptical cells, with two, three, or four *nuclei;* (*c*) elliptical cells, with the contents in a state of incipient fatty degeneration; (*d*) contiguous, fusiform cells, with a comparatively large, oval *nucleus*. × 450 diam.

Fig. 75, p. 333.—(*a*) The coating of a typhoid ulcer of the intestine, containing,—*nuclei*, minute, oval, nucleated cells, fine-molecular substance, and fat-globules; the other elementary bodies occurred in a mesenteric gland, which was infiltrated with a greyish-red and yellowish matter. × 350 diam.

Fig. 76, p. 341.—Gelatinous, viscous coating from the *cervix uteri*. (*a*) *Nuclei;* (*b, c*) pus-corpuscles; (*d*) mucin-filaments (represented by punctate lines, on account of their delicacy); (*e*) fusiform and caudate cells (some of the latter belonging to the epithelium). × 350 diam.

Fig. 77, p. 343.—Young connective-tissue-formations, from the concave surface of the placenta, of an aborted fœtus (15 inches long); round cells, with a large, vesicular, clear *nucleus;* fusiform cells with two diametrically opposite processes; tripolar cells (with three processes); quadripolar cells (with four processes); some of the cells in a state of fatty degeneration. × 350 diam.

Fig. 78, p. 344.—Connective-tissue-new-formation on the concave surface of the *placenta* of an aborted *fœtus* in the last months of pregnancy. Fusiform cells; among them rounded connective-tissue-cells. × 350 diam.

Fig. 79, p. 346.—Rusty-brown new-formation of connective tissue and vessels from beneath the parietal lamina of the arachnoid. (*a a*) Sacculated blood-vessel; (*b*) deep-yellow and reddish-brown cells; (*c*) cells only partially filled with pigment-granules; (*d*) cells without pigment, with a distinct *nucleus*, and close to these some escaped *nuclei;* (*e*) concretions (carbonate, phosphate of lime,) some free, some enclosed by a colloid substance. × 350 diam.

Fig. 80, p. 349.—New-formed vessels from a new-formation of connective tissue beneath the parietal lamina of the arachnoid. The character of the vascular ramification resembles that of the lax connective tissue in the normal state. × 15 diam.

Fig. 81, p. 354.—New-formation of blood. A tough exudation undergoing organization, on the visceral lamina of the *pleura*, divided by a horizontal section into two halves (*a*, *b*).

Fig. 82, p. 356.—New-formed vascular *plexus* on the visceral lamina of the *pleura;* irregular serpentine course and abrupt curves of the larger vessels; the type of distribution of the vessels is that of lax connective tissue. × 15 diam.

Fig. 83, p. 357.—Melanotic granulations on the pulmonal *pleura*. (*a*) Black, pigmented, flattened cells; (*b*) immature, minute connective-tissue-elements; (*c c*) decussating fibrous *fasciculi;* (*d*) numerous groups of blood-corpuscles, together with abundant, black, free pigment. × 350 diam.

Fig. 84, p. 362.—Vessels ramifying on the surface of an oval, transparent cyst, 0·177‴ [1·09‴?] in diameter, (*a*) seated upon the broad ligament of the *uterus*. × 30 diam.

Fig. 85, p. 364.—Elementary organs from the inner surface of the wall of an ovarian cyst of the size of a lentil. (*a*) Two cells with a parietal oval *nucleus*, and an encysted portion of contents; (*b*) two cells with a portion of contents divided into two parts; in the cell (*c*) they are divided into three parts; (*d*, *e*) degenerated forms; (*f*) cylindrical *epithelium* seen on the side; (*g*) the same viewed from above; (*h*) flattened, polygonal, contiguous epithelial cells; (*i*) fusiform cells of various dimensions. × 350 diam.

Fig. 86, p. 369.—Perpendicular section of a *papilla* from an acuminate condyloma. (*a*) Vascular loop; in the vertical axis of the *papilla* are delicate connective-tissue-fibres, towards the exterior, are seen *nuclei*, rendered clear by acetic acid; (*b b*) double contoured border of the papilla; from (*b*—*c*) on both sides, the epidermis-cells stand perpendicularly to the curved surface of the *papilla*; external to these (*c c*) they are disposed transversely. × 350 diam.

Fig. 87, p. 371.—The clavate extremity of an acuminate condyloma, 0·44‴ in diameter, with numerous *papillæ*, each of which contains a looped vessel; they are covered with a common epidermic coat. × 60 diam.

Fig. 88, p. 373.—Surface of a section of the base of a large *papilloma* on the *penis*. The cross-hatched shading in the centre, and the dark lines in the light-coloured lobules represent the dense connective-tissue, whose dendritic bundles branch out towards the surface of the growth. × 2 diam.

Fig. 89, p. 377.—Vertical section of a broad *condyloma*. From the surface (*b*) the expanding fibrous bands diverge in a fan-like manner, enclosing between them serpentine vessels. Towards the surface are apparent some enlarged sebaceous follicles (*a a*) immediately beneath the epidermis, which is indicated by a double contour line. × 5 diam.

Fig. 90, p. 379.—Vascular plexus on the surface of a subcutaneous condyloma. × 15 diam. (viewed by reflected light).

Fig. 91, p. 379.—Vertical section of a subcutaneous condyloma; from the surface of the skin, which is raised into a small eminence, depends, from a short peduncle the lobulated nodule. The interstitial substance, which is left light (*a a*), between the lobules, consists of immature connective tissue and vessels; the contents of the lobules are composed of layers not unlike epidermis-cells. × 15 diam.

Fig. 92, p. 384.—Portions of a perpendicular section of a so-termed lupose efflorescence. (*a*) Corresponding to the epithelial layer; (*b b*) clear border beneath the mucous layer; (*c*) distended *areolæ* filled with embryonic connective tissue; (*d*) three different kinds of connective-tissue-cells; (*e e*) still more distended *areolæ*. × 350 diam.

Fig. 93, p. 391.—Perpendicular section of a "so-termed keloid" from the abdominal integument. (*a*) Epidermic stratum; (*b*) *areolæ* filled with embryonic connective-tissue-elements. × 350 diam.

Fig. 94, p. 396.—Polypus of the ear. Perpendicular section prepared in the dry state. (*a*) Denser; (*b*) laxer areolar tissue; (*c*) epidermis-stratum; (*d*) the elementary organs enclosed by fibrous bundles; (*f*) cells that have escaped, × 350 diam.; (*e*) areolar passages with indistinct outlines, × 50 diam.

Fig. 95, p. 400.—Section of a tumour composed of embryonic cellular tissue (gelatinous sarcoma) treated with dilute acetic acid. (*a a*) The rounded or oval *nuclei*, which are left white, constitute systems of groups; (*b b*) series of fat-cells which existed in scanty numbers; between them are elastic filaments (*c c*), and embryonic connective tissue. × 350 diam.

Fig. 96, p. 406.—Fibrous, connective-tissue-tumour (fibrous *sarcoma*), supposed to arise from the fibrous sheath of the masseter. (*a*) Connective-tissue-cells of various forms; (*b*) the same, associated with a fine, elastic filamentary network; (*c*) 1, rounded groups of cells; 2, cells in mutual apposition; 3, in longitudinal rows. × 350 diam.

Fig. 97, p. 407.—Elastic tissue from a fibrous sarcoma. × 350 diam.

Fig. 98, p. 409.—A tumour composed of embryonic connective-tissue, and abounding in vessels (so-termed "caruncle"), from the orifice of the female urethra. (*a a a*) Peripheral part of several lobules, showing the terminal loops. × 15 diam.

Fig. 99, p. 413.—Reddish fibrous tissue from the surface of a uterine polypus which had been ligatured. (*a, b, c*) Bundles of fibres decussating at various angles, and approaching very closely to organic muscular fibres; (*d*) the elements of which they are composed, with escaped *nuclei*. × 350 diam.

Fig. 100, p. 414.—Section of uterine polypus which had been boiled in dilute acetic acid and dried. Systems of *nuclei*, acuminate at both ends, and lying in parallel and divergent directions. (*a a*) Systems of *nuclei* placed at a right angle, and, like the former, belonging to fusiform cells. × 350 diam.

Fig. 101, p. 417.—Various kinds of corpuscles from a soft uterine polypus. (*a, b*) Radiated corpuscle with a granular central mass; (*c*) granular corpuscle; (*d*) hyaline, pale-red globules; (*e*) flattened granular corpuscle, containing both granular and hyaline globules. × 350 diam.

Fig. 102, p. 422.—Dendritic papillary new-formation of connective tissue, seated on the inner wall of a follicle of the thyroid gland. (*a*) The stem of a thick excrescence, furnished with nodular protuberances and numerous minute papillary growths; (*b*) stem of an elongated excrescence supported on a slender neck; (*c*) stem of a straight, projecting excrescence. × 50 diam.

Fig. 103, p. 425.—New-formed tissue in a follicle of the thyroid gland. (*A*) Areolar fibrous *stroma*, with the epithelial-like lining of the *areolæ* (*a, b, c, d, e, f*); (*B*) solidified, hyaline, structureless, colloid masses; (*g*) *epithelium*, the intercellular substance of which is in a state of fatty degeneration; (*h*) blood-vessel containing numerous white blood-corpuscles. × 350 diam.

Fig. 104, p. 426.—New-formed tissue in a follicle of the thyroid gland. In the *areola* (*a*) the investing connective tissue contains elongated *nuclei*; (*b*) a smaller *areola* with a constriction; (*c*) fibrous bands surrounding the *areola*; (*d*) a blood-vessel showing a slight degree of atheromatous degeneration; (*e*) a vessel much degenerated, and with granule-masses resting upon it; (*f*) orange-coloured pigment, at + assuming a reddish-brown and black colour. × 350 diam.

Fig. 105, p. 429.—Section of a granular liver. (*a a*) The surface; (*b b*) rectilinear streaks of connective tissue; (*c*) lobule containing a black-brown pigmented network; (*d*) shows several light-coloured spots; (*e e*) lobules containing deep yellow pigment. × 60 diam.

Fig. 106, p. 431.—Liver beginning to assume the granular condition. (*a*) Portion of the surface of the liver, in this case presenting irregular erosions, in which the hepatic substance is exposed; (*b*) surface of a section, in which may be perceived the disposition of the yellowish-white and reddish-brown (shaded) hepatic substance. (Viewed by reflected light.) × 2 diam.

Fig. 107, p. 432.—Thick layers of decussating connective-tissue-bundles, with scattered, rudimentary hepatic cells, taken from callous streaks imbedded in the hepatic parenchyma. × 250 diam.

Fig. 108, p. 433.—Connective-tissue-cells of various forms in the liver of a new-born infant affected with *syphilis*. × 350 diam.

Fig. 109, p. 434.—Slate-grey liver, after intermittent fever. (*a*) Granules of *hæmatin* in the venous blood, of various sizes, at + +, enclosed in capillary vessels; (*b*) hepatic cells, partly or wholly filled with pigment-molecules; (*c*) *nuclei* of defunct hepatic cells, or newly formed; (*d*) new-formed connective-tissue-cells, with pigment-molecules in their contents; (*e*) fibre-cells. × 350 diam.

Fig. 110, p. 438.—From renal cysts. (*a*) Structureless, transparent, colloid-masses; (*b*) the same with processes; (*c*—*g*) cellæform bodies in the hypertrophied, interstitial connective tissue, with one, two, three, and several *nuclei*, of divers forms; (*h*, *i*) concentric colloid corpuscles; (*k*) circumscribed colloid masses, with fatty molecules disposed in an areolar manner. × 350 diam.

Fig. 111, p. 444.—The *capitulum* of the metacarpal bone of the middle finger, perforated in various directions by an *osteo-sarcoma*, viewed on the volar aspect. (*a*) An isolated portion of bone assuming the form of a process; (*b*) oval *fossa* with several openings, representing the base of the morbid product; (*c*) the remaining part of the articular surface. Nat. size.

Fig. 112, p. 447.—New-formation of cells in two cases of *osteomalacia*. (*a*) Rounded cells in the marrow of the *femur*; (*b*) the same, with *nuclei* of different shapes (exuberant medulla-cells or embryonic connective tissue); (*c*) cells from the medulla of a rib in a state of *osteomalacia*, taken from a woman affected with cancer in other organs (the cells probably cancerous). × 350 diam.

Fig. 113, p. 449.—Surface of a section of an osteo-cystosarcoma, from the sacral region in a child three days old. (*a*) Larger cyst cut off; (*b b*) cartilaginous portions of the *sacrum* and *coccyx*; (*c c*) papillary new-formations of connective tissue, springing out of shallow depressions. Nat. size.

Fig. 114, p. 449.—(*a*) Ciliated cells of various kinds from the inner surface of several cysts in the same *osteo-cystosarcoma*; (*b*) flat, epithelial cells, from the inner surface of the cysts in other parts of the growth. × 350 diam.

Fig. 115, p. 450.—Mode of ramification of the vessels in the same osteo-cystosarcoma. × 60 diam.

Fig. 116, p. 452.—Sarcoma of the parotid gland (?), presenting a granular texture, each granule consisting of a pedunculate group of roundish *papillæ* covered with *epithelium*. (*a*, *b*) Cells, of which the parenchyma was constituted. × 300 diam.

Fig. 117, p. 455.—*Cystosarcoma phyllodes* of the mammary gland. (*a a*) Vascular, lobulated portion towards the exterior of the tumour, where it was bounded by the skin; (*b b*) white agglomerations of epidermis-cells, of the size of a lentil down to that of a pea; (*c*) the remaining cortical layer of one of the white nodules; (*d*) *lamellæ*, defined by shallow grooves, which *lamellæ*, unlike those descending from the nodules (*b b*), could not be turned back; (*e*) lobulated part; (*f f*) papillary growths, of divers forms and sizes; (*g*) foliate growths, overlapping each other and placed in groups. Nat. size.

Fig. 118, p. 457.—Nodulated new-formation from a cystosarcoma of the mammary gland. × 50 diam.

Fig. 119, p. 467.—Section of an accessory middle lobe of the prostate. (*a*) Glandular parenchyma, with elements imbedded in it; (*b b*) a gland-duct divided transversely; (*c*) groups of *nuclei*, belonging to fibre-cells lying in a transverse direction. × 350 diam.

Fig. 120, p. 471.—Lymphatic glands (?) in the subcutaneous adipose tissue —(*a*) consisting of a thick fibrous capsule and granular contents; (*b*) the contents appearing to be constituted of a homogeneous, brownish-yellow substance. × 350 diam.

Fig. 121, p. 472.—Two superimposed layers of very voluminous fat-cells, of different sizes, from a *lipoma*. × 200 diam.

Fig. 122, p. 473.—Fat-cells from the same *lipoma*, dried, enclosing crystalline bundles (margaric acid ?). × 350 diam.

Fig. 123, p. 474.—Cholesteatoma of the brain, consisting of layers of epidermis-like cells, mostly with a parietal *nucleus*. Cholesterin plates are disseminated among the layers of cells. × 350 diam.

Fig. 124, p. 478.—(*a*) Fibro-cartilaginous layer from a portion of a fractured *cervix femoris*; (*b*) ossified portion, in the form of a bony spicule or *trabecula*, from another part. × 350 diam.

Fig. 125, p. 481.—Section made perpendicularly to the oblique line of a united fracture of the *tibia*. (*a*) The upper sclerosed portion; (*b*) cicatrix or uniting substance, constituted of a wide-meshed, delicate network of osseous rays. × 4 diam.

Fig. 126, p. 483.—Oblique section through the *femur*. (*a*) Thick wall of a voluminous, enchondromatous, spherical sac; (*b*) triangular surface of a section of an osteophyte; (*c*) point at which the soft cartilaginous substance perforated the compact cortex of the bone; (*d*) bluish-grey cartilaginous substance; (*e*) the inferior projecting part of the enchondromatous sac; (*f*) the condyle. Nat. size.

Fig. 127, p. 483.—Section through the lower end of the tibia, exhibiting cartilaginous deposits at (*a a*).

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Fig. 142, p. 517.—Osteodentin from the terminal part of the pulp-cavity in an extracted incisor. The dark central substance is surrounded with a layer of globular masses and brownish-red interglobular spaces. The new dentin exhibits radiating canaliculi, and a concentric striation at its periphery. × 350 diam.

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Fig. 150, p. 547.—Section of an epithelial cancer of the lip, which had been dried and treated with dilute acetic acid. Bundles of connective tissue, containing oblong *nuclei,* surround the collections of flattened cells. × 300 diam.

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Fig. 154, p. 559.—Portion of cancerous villus of the urinary bladder. (*a*) Smaller blood-vessel; (*a′*, *b*) a somewhat larger vessel, with numerous white blood-corpuscles collected in it, and of a simple structure. In the hyaline blastema are solitary, embryonic connective-tissue-elements in a state of fatty degeneration. × 350 diam.

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Fig. 159, p. 569.—Cancerous (?) growth from the *basis cranii*. (*a a*) External lobulated surface; (*b b*) the corresponding sectional surfaces of the divided tumour; (*c*) acoustic nerve. Nat. size.

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